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THIS MONTH'S COVER

It is harvest time in the orchards of Canada, and here is a typical scene in one of the many apple orchards of Nova Scotia.

(Photo: National Film Board of Canada)

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Editorial Comment

Our first anniversary

WITH this issue WORLD CROPS enters its second year. In our first number we stated our belief that there was a definite need for a journal which would present developments in modern agriculture throughout the world so far as possible in non-technical language. Obviously no single journal could cover such an enormous field in detail; all that could reasonably be hoped for was, by careful selection of material, to provide a review of some of the major advances and to set in perspective the bewildering array of fresh achievements which are today occurring.

After the first twelve months it is permissible to pause for a moment and survey the result. If the rapidly-increasing number of our subscribers and the numerous expressions of appreciation we have received can be accepted as a criterion it would appear that our assumption was justified and that we have achieved some measure of success.

We are deeply grateful to our numerous contributors and to the many official and unofficial agencies throughout the world which have so freely made information available to us. We are also sensible of the numerous kindly and helpful suggestions and criticisms we have received from many quarters. We feel that, given a continuation of these conditions, WORLD CROPS can look forward to a career of increasing usefulness among an ever-widening circle of readers.

Lime—the obvious neglected?

TODAY, with so many new advances in modern agriculture, it may seem banal to devote much discussion to lime. The fact that many types of soil need lime regularly is universally recognised; it appears in fact to be so well known that the intention to use lime may sometimes replace the actual operation.

Recent estimates of the over-all lime requirement for the soils of England and Wales make it clear that lime is still under-used and that many soils, to which some of the latest advances in agricultural chemistry are being applied, have not first been brought to a desirable pH status by adequate dressings of lime or ground limestone. This is all the more surprising when it is realised that ever since 1937 British farmers have been able to buy lime at a considerably subsidised price; indeed, in recent years, under the Land Fertility Scheme, as much as half the cost of both the material and its spreading has been paid by the Government.

In 1941 the intrinsic lime needs of English and Welsh soils were estimated at 15½ million tons of lime (as calcium oxide). This was, however, the total amount required to bring the entire acreage into a reasonably non-acid state—the initial or capital requirement rather than the annual maintenance quantity needed to balance annual lime losses. From the start of the subsidy scheme until 1949, a tonnage of 16 millions had actually been applied and a fresh estimate of the over-all requirement was made in order to see if the general position had been improved. In the circumstances it is disconcerting to find that the new estimate is still huge—14 million tons of lime, or twice this tonnage of limestone (calcium carbonate), being still needed. Both the 1941 and 1950 estimates are broadly obtained rather than highly accurate figures, but even so it still seems clear that twelve years of lime subsidies have not made any appreciable difference to the real problem of soil acidity. At the most, the drift towards general acidity has only been checked, although it is possible that, as a result of the intensification of British agriculture since 1940, there has been rather more to hold in check than was anticipated in 1937.

One of the conclusions is that 1½ million tons of lime are needed merely to balance the annual losses and only lime applied in excess of this amount each year makes any contribution towards reducing the accumulated deficiencies of the past. It would be difficult to justify any increase in the present rate of subsidy payments; indeed, it is arguable that lime may have been made too cheap to be properly respected. Moreover, the production of lime has not been encouraged by the subsidy scheme, and this also may well be an adverse factor. Figures are not available, but it seems possible that the tonnage of lime applied to English and Welsh soils may be the tonnage that is in fact available. Should this be true, the lime subsidy scheme would seem to have failed in its main purpose.

Post-war ' working parties ' have been set up to consider problems of smaller national import. A ' lime party,' charged with the task of re-drafting the present subsidy scheme and encouraging both the application and the production of ground limestone, would perhaps be the quickest means of rescuing this essential agricultural material from neglect and apathy.

Colonial development

THE report and accounts of the Colonial Development Corporation for the year 1949 published on July 21, provides a wealth of information on the work of this body; incidentally it should not be confused with the Overseas Food Corporation, which is responsible for the Tanganyika Groundnut Scheme.

The Corporation is the instrument established by Act of Parliament to assist all types of development in the Colonial Dependencies. It operates under the aegis of the Colonial office, funds being derived from advances made by the Imperial Treasury. By the end of 1949, 28 undertakings were in operation with an aggregate capital of £14,187,000, and at a press conference held on the day of publication Lord Trefgarne, the Chairman, announced that by then the number of undertakings had increased to 44 and the financial commitment to £26,423,000.

Of the 28 schemes operating at the end of the year, 10 were agricultural, 2 related to animal products, 4 to forestry and 4 to fisheries, the remainder having to do with other aspects of development. Agricultural schemes are in operation in the Gambia, Nigeria, British Honduras, Malaya, North Borneo and Nyasaland and relate to rice, oilseeds, cocoa, bananas, manila hemp and tung oil. Projects are stated to be under consideration for the extension in other dependencies of rice cultivation, the production of vegetable oils with special relation to coconuts and oil palms, the increase of cocoa cultivation in view of the threat to the West African industry, the growth of fibre crops notably jute substitutes and ramie, and the production of high-grade flue-cured tobacco.

A welcome sign is the abundant caution with which the Corporation has approached its programmes; thus one learns that out of the 396 schemes which had been submitted to it by December 31 last no less than 250 had either been rejected or withdrawn. It is moreover satisfactory to read that ' it must be appreciated that in some of the areas in which the Corporation is called upon to operate there is little specific knowledge about soils, the performance of particular crops or the incidence of disease. . . . Consequently, nearly every development scheme undertaken by the Corporation must be preceded by extensive investigations on the spot which are often expensive in time and money. Even when the results of preliminary investigations justify the preparation of land for agriculture, it is often necessary to undertake further trials to select the highest yielding strains of the various crops . . . and to determine their most suitable rotation '.

With such a wide programme it is impossible to expect that every scheme will immediately or even ultimately be crowned with success. Agriculture is at best such a very chancy business that a proportion of failure is inevitable; but the spirit of realistic appreciation of the difficulties and the determination not to embark upon projects without the most searching examination and preliminary experiment which are so abundantly in evidence throughout the report are the best possible guarantees that the proportion of failures is likely to be minimal.

It is very much to the point also to read that the Board feel that there is no danger of complacency and that they expect that failure and mistake will be criticised while hoping that success will not be disregarded. There appears to be every ground for sharing their belief that the Corporation provides the Commonwealth with a powerful economic instrument and that it would be a grave disservice if its operations should be made a matter of party controversy.

Genetics in Russia

WE are accustomed to having our ideas roughly jostled by emanations from the U.S.S.R., but the situation that has arisen from what has been termed the Lysenko controversy must still cause some amazement, for what has taken place is that in 1948 the science of genetics and all that it stands for was officially banned throughout the Soviet Union.

The crux of the controversy is that Lysenko and his followers maintain that habits and characters of plants are determined by their environment and that the Mendelian theory of heredity is founded upon error.

In two recent American books (' Heredity, East and West; Lysenko and World Science ' by Julian Huxley and ' Death of a Science in Russia ' edited by Conway Zirkle) the well-nigh incredible story is told. Lysenko and his forerunner, Michurin, have undoubtedly succeeded in producing large numbers of improved varieties of crops, Michurin in the horticultural field and Lysenko in arable crops, working with very impure genetical material. Lysenko has also produced marked improvements in yield through simple cultural devices, *e.g.* manuring, weed control in arid areas and adjustments in spacing. This is not surprising as agricultural practice in the Soviet Union was previously at a low level.

Their work was criticised by Russian geneticists, to whom Lysenko retorted that his methods had produced practical results far superior to anything achieved by the former. He is a strong personality with a ready tongue and pen, and, above all, a good administrator and a staunch supporter of the Soviet regime. His views accordingly triumphed.

Genetics have been banned in Russia; its professors have been deprived of their posts and some have disappeared under mysterious conditions. Presumably the chromosome and the gene are regarded as undesirable figments of the bourgeois imagination, and the achievements of geneticists, to quote, for example, the recent remarkable work on disease-resistant cottons in the Sudan, are either disregarded as non-existent or as deliberate perversions of the true faith.

It is inherent in Western ideas that science thrives on controversy and that if it is forbidden

progress stops. In Russia, apparently, the reverse is believed, and those who hold views contrary to the accepted ' scientific ' tenets can only pursue their work subteranneously and in danger.

One is inevitably reminded of the tale of Galileo in the middle ages who, after torture, publicly recanted his discovery that the earth revolved round the sun, but who is reported to have remarked subsequently, *sotto voce*, ' nevertheless it does revolve '. One wonders how many Russians continue to harbour similar sentiments about chromosomes.

In the end truth will no doubt triumph and we cannot but feel that the policy of endeavouring to stem the tide of scientific enquiry is likely to prove as unavailing as the efforts of King Canute and his courtiers to stem the rising of the sea.

UNSCCUR in retrospect . . .

THE publication of the first of the seven volumes of Proceedings of the United Nations Scientific Conference on the Conservation and Utilisation of Resources, the full but somewhat overlong title of the gathering held last August at Lake Success which has become colloquially known as UNSCCUR, prompts some reflections on that remarkable assembly.

The volume in question deals only with the plenary sessions ; it contains 82 papers and discourses with reports of the discussions thereon, and runs to nearly half a million words. If the other volumes are of similar size the complete work will assume encyclopaedic proportions. Indeed, encyclopaedic is really the only word to apply, for it contains the distilled wisdom and experience of authorities in many lands on a vast range of topics, is largely shorn of abstruse technicalities and is readily comprehensible to the non-technical reader. In making such a mass of information available the conference has therefore rendered a signal service, and this is not detracted from, even when one admits that it is only half the picture inasmuch as unhappily no representatives were present from the countries behind the Iron Curtain, and information concerning conditions in them is consequently not included.

It may not be generally known that the original proposal to hold a conference of this type dates back to as long ago as 1909, when the late President Theodore Roosevelt pointed out that the ' planned and orderly development of the earth is indispensable to the permanent prosperity of the human race ' and issued an invitation to 58 nations to ' join together in conferences on world resources, and their inventory, conservation and wise utilisation.' This invitation was accepted by 30 countries but was later withdrawn by his successor, President Taft, and the matter was left to languish till 1940, when it was raised again at the 8th American Scientific Congress. The outbreak of war then precluded action, but in 1944 the idea was again vigorously taken up by President Franklin Roosevelt and, on his death, by President Truman, who put behind it the full measure of his authority and expressed the hope that it would bring together new techniques for conserving and developing resources, particularly of undeveloped countries.

Thus, after 41 years, the conference materialised. It was in many respects a unique gathering even in that land of conventions, the U.S.A., and great things were hoped from it. It was attended by 700 scientists and technicians and its meetings were widely publicised ; incidentally, accounts of some of its features appeared in this journal. The appearance of the first instalment of its proceedings removes the immediate danger of its being relegated to the limbo of things forgotten and renders possible some appraisement of its results.

. . . and in prospect

But when one has said this, apart from the value of the personal contacts and experiences of delegates, it is a little difficult to appreciate what more the conference has accomplished. One fears indeed that, in these conditions, like many other encyclopaedic efforts, there may be a risk that its proceedings may mainly serve to decorate official bookshelves and be used only as a work of occasional reference. In this event the conference would only have achieved the parturition of a somewhat outsized mouse.

Under its terms of reference the conference was limited to an exchange of views and it was specifically directed that it should have no policy-making responsibilities and would not make recommendations to Governments. One cannot but feel that this decision may not have been altogether a happy one. It seems to involve the assumption that a scientific background and technical qualifications automatically disqualify an individual from having any major say in the implementation of policies which stem from his achievements.

As one delegate to the Conference—Mrs. Giffard Pinchot—trenchantly put it : ' What Humpty Dumpty nonsense is this and since when have scientists become so dangerous that they are not to be trusted with the little power implied in the making of a recommendation ? '

Granted that the framing of resolutions and getting agreement on them is, as one delegate pointed out, a time consuming and arduous operation, nevertheless perusal of the debates indicates that there was a large measure of agreement on many important questions and one is tempted to enquire whether it would not have been as well, wherever unanimity of opinion existed, formally to have placed this on record. It would certainly have crystallised something from what is at present an amorphous mass of extremely valuable material.

That the need for crystallisation is now appreciated by UNO authorities is, we think, plain from the concluding paragraphs of the note by the Secretary General to the Social and Economic Council which forms the introduction to the volume, and which recommends that steps should be taken to obtain the proposals and suggestions of participants in the conference. If this is done it should to an extent help to clarify matters, but at best it seems a very roundabout procedure and one cannot help feeling that the same result could have been much more effectively and expeditiously secured when all the participants were assembled together at Lake Success.

Mining and agriculture

IN a planned economy inevitably from time to time conflicts arise between the claims of various aspects of land use, and in no case is this more in evidence than in that of mining.

Wherever recoverable minerals exist their extraction necessarily involves the suspension of agriculture to a greater or less degree in their vicinity. Obviously, when mining operations are finally suspended, the mined land should be left in a rich condition that agricultural operations can be resumed thereon effectively, but in the past this has unfortunately been far from achievement in actual practice; with growing world populations it is becoming more and more important. In Great Britain the question has been thrown into high relief lately by reason of the controversy which has raged and is still raging around the open-cast mining of shallow coal and iron deposits which have been undertaken at the instance of the Government to supplement inadequate supplies from deep level working.

It seems not improbable that in the aggregate the total area of agricultural land likely to be affected by these operations is far exceeded by the area despoiled by the dumping of tailings from deep level mining, but the fact that it does entail the removal from cultivation of not inconsiderable areas, even if only for a time, has caused alarm and has directed attention to a matter which is really of profound and world-wide significance.

The crux of the matter is that methods are wanted which will allow urgently needed minerals to be extracted with the least amount of damage to the surface soil and permit the mined land to be restored to agricultural use as efficiently and quickly as possible. This is indeed one of the conditions under which open-cast coal mining in Great Britain has been undertaken, and the position is accordingly of considerable interest.

The question was discussed in a paper recently read before the annual general meeting of the Society of Chemical Industry by Mr. B. M. Dougall. Originally the overburden was removed as one layer and replaced haphazard. This resulted in the complete loss of the topsoil and, in these conditions, long periods were required to enable the land to be restored to agricultural use, even if it could be accomplished at all in measurable time.

More recently it has been sought to circumvent this by keeping the top layer of soil separate and returning it to the land after the remainder of the overburden had been replaced. Even so, results have not been entirely satisfactory, although it represents a decided advance. Excessive consolidation of the topsoil occurs during stacking, leading to loss of crumb structure and to anaerobic conditions in the stack which profoundly affect the biological balance in the soil. Moreover, the extraction of minerals may lead to alterations of level and create difficulties of drainage which did not exist before, while the sequence of cultural processes best calculated to restore fertility need to be worked out. Obviously these may vary quite considerably with variations in the type of soil and subsoil and the lie of the land.

It is certainly all to the good that an active programme of experiment is in progress under the aegis of the Coal Board working with the agricultural authorities and which may provide a solution for the immediate British problem. If this is so, it may well be that it will direct attention to the even more important and wider aspects presented by the problem elsewhere, notably where mineral wealth occurs in the form of widespread alluvial deposits, which can only be recovered by open-cast working or by dredging. A case in point is Malaya, where large areas of agricultural land have been laid waste as the result of operations to recover the alluvial tin which constitutes so important a fraction of that territory's natural wealth.

The fact that deposits of this kind naturally cover a wide area and are located in alluvial plains, which usually comprise some of the richest agricultural lands, makes this aspect particularly urgent. Mining by dredging adds to the difficulties, since even if the topsoil is removed separately and restored after mining is complete, which is at present rarely done because of the alleged additional expense, the extraction of the ore from the dredged material entails the mechanical separation of the coarser from the finer constituents of the subsoil; unless means can be found to recombine them after mining has been completed, the structure of the subsoil is profoundly modified and this may quite well affect its capacity to grow crops.

In these times when the conservation of natural resources is rightly regarded as of the most profound importance, the world simply cannot afford to neglect these aspects, and while it is obviously essential that full advantage should be taken of valuable mineral deposits no matter at what levels they occur, it is equally essential that the mined lands should be restored as effectively and speedily as possible to a condition favourable to agriculture.

Sugar — Mainstay of the British West Indies

Part II

ARTHUR C. BARNES, C.M.G., B.Sc., F.R.I.C.

Director of Research for the Sugar Manufacturers Association of Jamaica

This is the second part of Mr. Barnes' article on the sugar industry of the British West Indies, which started last month. In this section a general description is given of production conditions in each of the sugar growing colonies.

Harvesting sugar cane in Barbados

Raising seedling canes in pots, Barbados

HAVING reviewed in Part I the general circumstances of the British West Indian sugar industry we can now proceed to consider briefly the situation in the various individual colonies. In doing so it is convenient to connect the sequence of treatment with the flight schedules of British West Indian Airways from north to south.

Jamaica

Jamaica is situated between 17° 43′ and 18° 32′ North latitude and 76° 11′ and 78° 21′ West longitude. The total area is 4,411 square miles, of which the greater part consists of hilly and mountainous lands, the highest altitude being 7,402 ft. at the Blue Mountain Peak in the east. There are wide ranges of climate and rainfall, from the hot humid coastal plains to the cool uplands, with less than an average of 30 in. of rain yearly in the south central coastal areas to more than 100 in. in the north-east. The mean maximum and minimum temperatures of Kingston, the capital in the south-east of the island, are 87.6° and 71.2° respectively, the average rainfall for 70 years being 31.86 in. per annum. The island occasionally experiences hurricanes which cause damage to standing crops, though as a rule sugar cane is not seriously affected.

Agricultural conditions

Approximately one-seventh of the total area consists of cultivable land of which 383,000 acres were in cultivation in 1942, 95,710 acres being planted with sugar canes. Soils range from light alluvia with good drainage to heavy clays with impeded drainage. Sugar estates and factories are mainly situated near the coast, though some are inland. There is a good and extensive system of roads and a government railway of standard gauge. In addition to Kingston there are 19 shipping ports, four of which are rated as first class and the remainder as second class. The population at December 31, 1948, was reported to be 1,362,110 persons.

The major activities are agricultural, though secondary and manufacturing industries have developed during recent years. A great variety of products is grown, of which the principal is now sugar cane. For many years bananas held the premier position and the decline of that industry through the effect of disease has been partly responsible for the marked increase in cane sugar production. Other main products include citrus fruit, coconuts, tobacco, maize and, recently, tomatoes. Cattle rearing for beef and dairy purposes is also important.

Sugar production

Sugar production has long been important. Intimately associated with it is the manufacture of rum from the by-product molasses, and all sugar factories in Jamaica have distilleries attached to them.

During the past 30 years there has been marked centralisation of the manufacture of sugar as well as a steady increase in annual production. In 1920, 59 factories made a total of 40,212 tons of sugar, while in 1949, 237,744 tons were produced by 23 factories.

Increased use of mechanical methods of cultivation has enabled greater crops to be grown without considerable increase in labour requirements, but for harvesting and transport they have grown more or less in proportion to the expansion of the crop. Mechanised agriculture, the careful use of fertilisers and better land management have contributed to the increased yields of cane and sugar. A further important feature has been the introduction of new and improved varieties of cane from the B.W.I. Central Sugar Cane Breeding Station in Barbados, from which final selections for commercial planting are made, after experimental trial. This has brought about remarkable changes in the varieties of cane grown by estates.

Aerial view of a part of the front lands of British Guiana showing sugar cane cultivation and drainage canals

Irrigation

More than 40% of the crop is grown under irrigation in the southern central area where rainfall is deficient. In the eastern portion the principal source of water is the Rio Cobre Irrigation Scheme, while in the west the so-called Cockpit Scheme is the largest similar source. Both were established by the Government and are operated under appropriate legislation. In addition there are numerous tube wells on estates from which water is pumped for the irrigation of localised areas while other estates outside the dry belt have local gravity irrigation systems.

Production

In 1949 the sugar crop of 237,744 tons was derived from 2,212,220 tons of cane, of which 637,346 tons were grown by cane farmers. During the past 16 years production by cane farmers has greatly increased; thus in 1934 they supplied 13% of the cane used to make 72,420 tons of sugar, whereas in 1949 they were responsible for 28.81% of the cane used to produce more than three times that quantity. The relationships of cane farmers with factories are governed by the provisions of the Sugar Industry Control Law. Since 1938 cane farmers have been required to register with the factories they supply, and factories can purchase cane only from registered farmers. The total number of registered farmers at the end of August 1949 was 12,430.

Local consumption of sugar has increased of late years and is estimated to be 50,000 tons in 1950. One of the larger factories (Monymusk) operates a refinery in this connection.

Rum-making

The manufacture of rum from molasses holds an important position in the economics of the industry. In 1931 the market became depressed, and the Rum Pool, operating in conjunction with the Sugar Manufacturers' Association, was formed. Since then all rum has been made in fulfilment of orders, and sales have been pooled, the profits being distributed to factories on the basis of tons of cane ground. Production approached three million gallons in 1948 and 1949, which was about twice the annual production ten years earlier. The market outlook has, however, now become less favourable, and restricted output is planned in 1950.

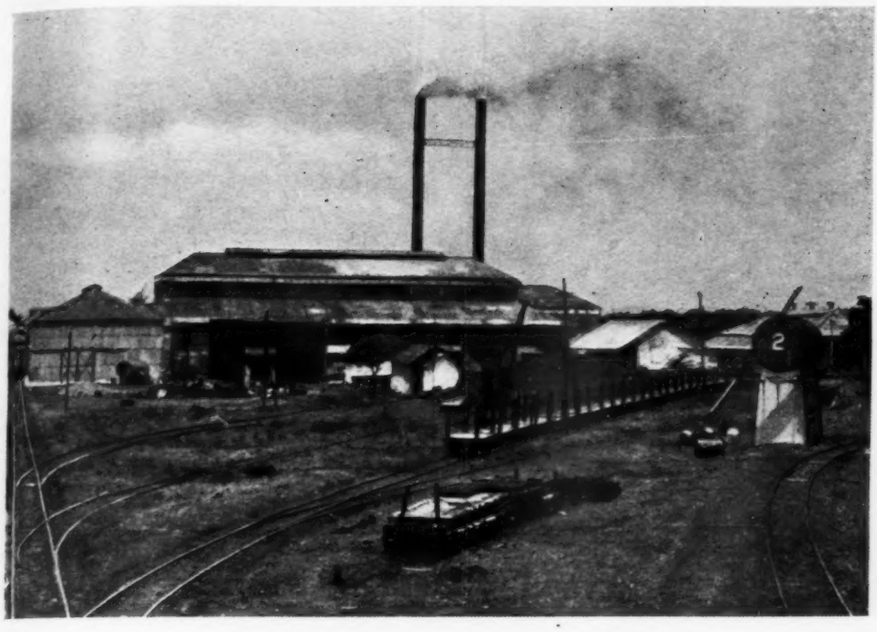
Research

The Sugar Manufacturers' Association (of Jamaica) Limited plays a dominant part in the affairs of the industry. The expenses of the Association are defrayed from a cess on local sales of sugar and rum, which are conducted on a pooled basis. The Association serves the industry in a variety of ways. Its research department, established in 1943, has assumed responsibility for the investigational work, formerly undertaken by the Department of Agriculture. The headquarters at Mandeville are centrally situated with respect to the estates, factories and distilleries. Field experiments are conducted on estates, the main lines of investigation being directed to soil and fertiliser studies and the introduction and testing of new varieties of cane. A 10-acre nursery for this work has been established at Caymanas. The senior scientific staff numbers six in addition to office staff and a number of junior assistants. Close contact is maintained with all estates, who are kept informed of progress of the investigations and advised on points of interest. The staff keep in close touch with the progress of similar work in other sugar producing countries. Some of the larger estates have set up their own research organisations, which work in close co-operation with the Research Department of the Sugar Manufacturers' Association.

The Jamaican Association of Sugar Technologists promotes the discussion of technical problems and the publication of matters of interest. It has sections which consider matters of interest in the agricultural, chemical, engineering, and administrative branches. Annual conferences are held, and a journal is published yearly. Its Chemical Control Committee has brought about a high degree of standardisation in the chemical control of factories and distilleries.

The Leeward Islands

This colony comprises St. Kitts, Nevis, Antigua, Montserrat and the Virgin Islands. Sugar is mainly grown in St. Kitts and Antigua which together produce from 40,000 to 60,000 tons of sugar annually. With the exception of Nevis, where production is still maintained on a small scale, sugar growing has largely died out in the other islands.



The Basseterre sugar factory, St. Kitts

St. Kitts

The island of St. Christopher (St. Kitts) is 750 miles distant from Jamaica and is situated in latitude 17° 18′ North and longitude 62° 48′ West. In shape it is rather like an Indian club. The north-western portion is an elongated oval, 14 miles long and 5 miles wide, having a central rugged mountainous range with its highest point, Mount Misery, 3,711 ft. above sea level. The total area is 68 square miles, with a population of 29,818 (census of 1946). The average annual rainfall for 34 years—1914 to 1947—was 54.36 in., but considerable variations occur between the coastal plain and the uplands as well as from year to year. During the period mentioned the highest and lowest annual rainfalls were 77 in. (1932) and 34 in. (1923).

The whole economy of the island is dependent upon sugar, the cane being grown on the coastal plain encircling the north-western part, and on the inland slopes where the terrain is suitable for the crop. In common with other islands of the B.W.I. the sugar industry of St. Kitts suffered from severe depression during the closing years of the 19th century and the early 1900s. Apart from the external factors already discussed, inefficient small muscovado factories, driven by windmills or steam, were operated by individual estates, and their low extraction of sugar contributed to the impoverishment of the industry. In 1912 a modern central factory—the St. Kitts (Basseterre) Sugar Factory Ltd.—was erected and commenced the manufacture of sugar. It handles the whole of the cane produced in the island and has now been in successful and highly efficient operation for 38 years. Prior to this the planters were losing 40% of the extractable sugar in their cane, and it has been estimated that in the first 14 years the new factory recovered 47,000 tons more than could have been got by the old mills from the same quantity of cane, the value of the sugar thus saved being in excess of £950,000.

The Factory Company grows no cane itself, but accepts deliveries from the 47 estates in St. Kitts which supply all but a small quantity of the total crop, the remainder being derived from small growers on land settlements and from the adjoining island of Nevis. The total area harvested annually is approximately 10,000 acres, the St. Kitts' crop being delivered to the factory by a 30 in. gauge railway which circles the main area of the island. Cane from Nevis amounting to 5,000 tons or so yearly is carried by sea.

Apart from the efficient extraction of the factory, improved yields of cane have been obtained by the estates as a result of organised investigations carried out since 1933 by the Sugar Cane Investigation Committee and various workers. From that time the damage and loss caused by the moth borer (*Diatraea saccharalis*) has been progressively reduced by the agency of the Cuban Fly (*Lixophaga diatraea*). Mechanisation of field operations and cane transport has advanced considerably during recent years. Contour cultivation is practised and the use of artificial manures has increased remarkably since 1933. Like other sugar-producing territories of the Caribbean, the industry in St. Kitts has derived great benefit from the work of the B.W.I. Central Sugar Cane Breeding Station in Barbados. Indeed it may be said that agricultural research has played a highly important part in improving the economy of cane production, while on the technical side the factory has contributed by a consistent and high standard of efficiency. 35,667 tons of sugar were produced in 1949, the five-year average for 1944-48 being 31,086 tons.

Antigua

Antigua, about 30 minutes flying time to the east of St. Kitts, is another of the 'sugar islands,' 108 square miles in extent. The history of the industry and its present condition closely follow the pattern of St. Kitts. The rainfall is lower with an annual average of about 43 in., ranging from 35 in. to 45 in. over the cane areas. Like St. Kitts the sugar industry is the predominant activity. At the time of the Norman Commission in 1897, sugar production was entirely an estate industry with 71 factories, of which 17 were windmill and 54 steam driven, all making muscovado sugar. As in St. Kitts, the manufacturing processes were wasteful, some 14 tons of cane being used to make 1 ton of sugar, compared with about 8 tons in the present modern central factory—The Antigua Sugar Factory Ltd.—which commenced operation in 1905 with a crop of 1,634 tons of sugar and now handles practically the whole output of the island. It has been enlarged and improved, and is now capable of an output in excess of 25,000 tons annually. The only remaining muscovado works is at Montpelier. The central factory purchases the whole of the cane ground by it, the supply coming from grouped and individual estates and from peasant growers.

Field investigations, commenced in 1891 and intensified in 1933, have made major contributions to improvements in cultural practices which have brought about higher yields. Crop fluctuations are related to the periodical droughts which characterise the climate, and in general the yields of cane and of sugar per acre are lower than in Jamaica or St. Kitts. In recent years difficulties with labour have intensified and interfered with the progress of harvesting and manufacturing operations both in Antigua and St. Kitts to a greater extent perhaps than in other parts of the B.W.I. Thus in 1948 the combined effects of drought in 1946 and 1947 and of strikes during the cropping period caused a drop in the production of sugar to 12,174 tons in Antigua compared with almost twice as much in the previous year. The output in 1949 was 18,149 tons.

Barbados

Continuing from Antigua, Barbados is reached after less than two hours in the air. The route by-passes St. Lucia and St. Vincent, both of which produce sugar in comparatively small quantities. Barbados, the most easterly of the islands in the B.W.I., lies in latitude 13° 4′ North and 59° 57′ West, and is 166 square miles in area. It has a remarkably high density of population, considerably in excess of 1,000 per square mile. The island provides a picture of well ordered agricultural activity, sugar cane being the principal crop. Various vantage points enable the observer to overlook extensive areas of cane with sugar factories dotted through the landscape. Bridgetown, the capital, situated on the south-west, is a busy port where large liners and motor and sailing vessels of all descriptions make up picturesque seascapes.

The dominance of sugar is more apparent than in any other of the sugar islands. The industry, both in field and factory, is highly efficient and is a tribute to applied research conducted for many years by the Department of Science and Agriculture, and to the technical skill of the engineers, chemists and operatives of the factories. The B.W.I. Central Sugar Cane Breeding Station established in its present form in 1932, carries on the work of producing new cane varieties initiated many years earlier by J. R. Bovell and Sir John Harrison, and has evolved many new and improved canes now in extensive commercial cultivation not only in Barbados, but throughout the Caribbean area. Mosaic disease is no longer a problem, but moth borers (*Diatraea saccharalis*) and, in localised areas, root borers, damage the cane and require special methods to combat their ill-effects. The former is partially controlled by the egg parasite *Trichogramma minutum*, which is specially bred by the Department of Agriculture for liberation in the cane fields.

The average annual rainfall is about 64 in., but as in other islands considerable variations occur from year to year. There are three well-defined rainfall areas characterised as low, intermediate and high, with corresponding effect on growth and yields of canes.

In the low and intermediate rainfall areas the cane is mulched with grass which is cut and loaded mechanically and transported for application to the land. The importance of conserving soil moisture and fertility by this and other practices including the use of the dead leaves or trash from the cane at the time of reaping is well recognised. Additional yields of about 5 tons of cane per acre are obtained. Careful work over a long period has determined the optimum rates of application of artificial fertilisers and of grass for mulching the cane fields.

Until recent years there was very little mechanisation of field operations, but of late the use of tractors and implements has developed. The extensive growing of food crops in sugar cane land prior to replanting has great importance in relation to the production of as high a proportion as possible of locally-grown food.

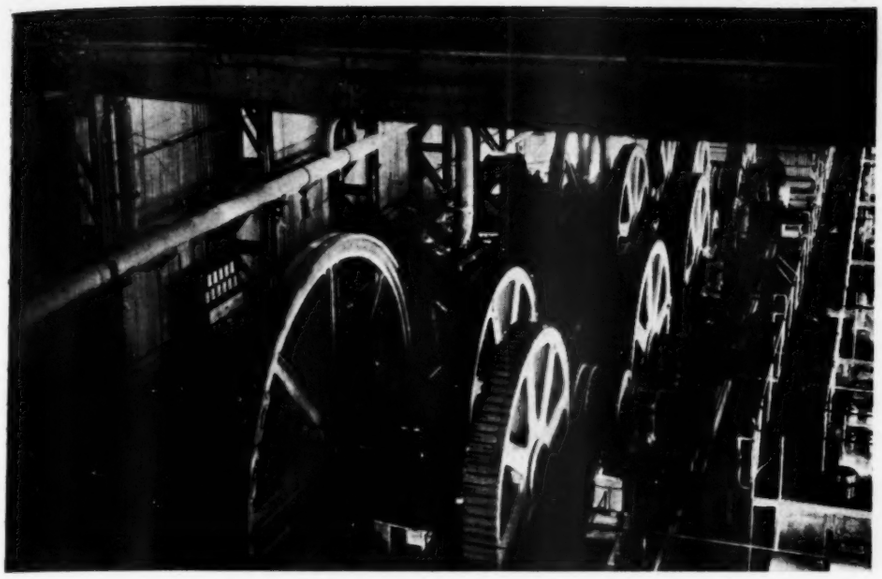
A feature of the Barbados industry is the production of various grades of fancy molasses, marketed principally in Canada, and representing a considerable proportion in terms of sugar of each annual crop. As recently as 1940 there were 35 small steam plants and 37 windmill plants manufacturing fancy molasses and a small amount of muscovado sugar, in addition to 31 vacuum pan factories making refinery raws. Since then there has been a reduction in these numbers, with considerable improvement in the equipment and the output of some of the more modern factories. Though a few windmills still remain, none are now used for crushing of cane. The total production of sugar, including fancy molasses, in terms of sugar, was 152,731 tons in 1949, almost twice as much as in the previous year during which the crop had been gravely affected by drought.

Seedling canes at the B.W.I. Central Sugar Cane Breeding Station, Barbados

Trinidad

Trinidad is reached from Barbados after about 1¼ hours' flying to the south-west. It lies to the east of Venezuela from which it is about 16 miles distant. Its area is 1,863 square miles, and with the small island of Tobago to the north-east it forms an administrative unit. It is the last, though not the least in importance, in this series of the sugar islands of the B.W.I. The sugar estates are situated on the mid-western coastal plain running into rolling and more hilly land in its southern portion, facing the Gulf of Paria. Prior to 1920 there was a considerable number of small factories, but during the past 30 years progressive centralisation of manufacture, together with the practice of mechanical methods in the field, have brought about a high degree of efficiency. Until the new Monymusk Factory was erected in Jamaica, Trinidad had the largest sugar factory, the St. Madeleine, in the British Empire. A high proportion of the sugar cane ground by the eight factories now in operation is grown and supplied by cane farmers, their relationships with factories being controlled by the Cane Farming Control Ordinances. Farmers' holdings range from a fraction of an acre to over 500 acres each, and they supply a considerable but varying proportion exceeding ⅓ of the total crop manufactured into sugar. The number of cane farmers varies greatly from year to year, ranging from just over 10,000 to well over 20,000 in different years, depending upon the attraction and remuneration available from other occupations, such for example as the oil industry which is centred near to and to the south of the cane areas.

For many years intensive research into the varied problems of sugar cane production has been conducted by the Department of Agriculture, the Imperial College of Tropical Agriculture and the Sugar Manufacturers' Association. Mosaic disease is not important but the sugar cane frog-hopper (*Tomaspis saccharina*) causes heavy losses, and until recently was found extremely difficult to control. The discovery of modern insecticides such as



The mill house, Frome Central Factory, Jamaica

Gammexane and DDT, and their application to the control of this pest now offer what is an apparently satisfactory solution. The serious effects of frog-hopper infestation may be judged from the fact that in some years it was responsible for an annual loss of cane over parts of the cropped area amounting to no less than 10 tons per acre. Minor damage is caused by moth borers and other insect pests.

The Trinidad sugar industry has played a leading part in the application of mechanical methods to field operations including drainage, and one estate, Woodford Lodge, has given its name to a system of land management involving the use of cambered beds, with a special ploughing technique, and inter-row cultivation by the rotary hoe. The average annual rainfall is about 63 in. but as in other islands it varies from year to year, the maximum and minimum over a 20-year period being 90 in. and 45 in. respectively. Replacement of older varieties of cane by new ones produced at the Barbados Cane Breeding Station has taken place and is still continuing.

Sugar production in 1949 was 159,135 tons.

British Guiana

Although British Guiana is not considered to be a part of the British West Indies, it naturally falls within the compass of a descriptive account of sugar in the colonies of the Caribbean area. Situated on the mainland of South America, to the south-east of Trinidad, it is 83,000 square miles in extent. The sugar cane lands are on the coast, which is to the north-east, and comprise a strip of low-lying areas reclaimed from the sea and from swamps fed by five rivers which discharge into the Atlantic Ocean. Extensive sea walls give protection from the encroachment of the sea, while dams, drainage canals, sluices and pumps control the influx of fresh water from the interior. The cultivated area is in these respects similar to the fens of England, and the reclaimed and drained areas of the Netherlands. The soil thus won by persistent and continued effort is highly fertile. Sugar production in all its stages involves an unremitting contest with water. Two levels of waterways are maintained by an intricate canal system, the higher canals being used for irrigation and transport and the lower for drainage. Apart from the sea and the inflow of fresh water from the interior, the heavy and varying rainfall necessitates provision for the removal of excess water. While a few estates can drain by gravity to the sea or to the rivers at low tides, costly pumping equipment is required by most of them, and though pumping lifts are low, immense volumes of water have to be moved. It has been estimated that each square mile of cane cultivation needs almost 50 miles of drainage canals and 16 miles of high level channels, a total of some 5,000 miles for the entire cane lands of the Colony. Apart from the expense of pumping, heavy annual expenditure is involved in cleaning the water system of each estate and the maintenance of the dams. Indeed sugar cane production in British Guiana may well be called an amphibious operation.

Mechanisation of land preparation and cultivation has become normal practice. Sugar yields have increased as a result of improved methods and the application of the results of research as well as by the growing of better cane varieties. Until recently cane breeding was carried on in the Colony, but now the industry participates in the work of the cane breeding station in Barbados, where special attention is devoted to the particular and exacting requirements of the most unorthodox sugar country in the world.

An interesting feature of land management is the flood fallowing system. Fields which are to be replanted are flooded with water to a depth of at least a foot above the highest part of the beds for about six months. In this way weeds are killed and the old cane roots and trash rotted, while aquatic weeds develop to be ploughed in after the water is removed. The effect of this is to improve the soil tilth and increase its fertility. Artificial fertilisers, particularly sulphate of ammonia, are in general use.

The total area in cane cultivation is about 70,000 acres, of which between 70% and 80% is available for harvesting each year, yielding slightly more than 3 tons of sugar per acre. As in Trinidad, the cane is fired before being reaped. It is carried by head-load to the high level canal banks and there put into punts for transport to the factory. 'Trains' of punts are hauled by mules or rubber-tyred tractors, the whole of the crop being waterborne. In general, factory efficiency is good, and is being further improved by modernisation. The annual sugar production during each of the past two years has exceeded 170,000 tons, the record being 196,502 tons in 1938.

Rum is made in considerable quantity, but the whole of the molasses available is not so used, and varying quantities are exported. The rum produced in 1948 amounted to 3,562,073 gal., and in that year nearly $1\frac{3}{4}$ million gal. of molasses were shipped also.

(Photos: p. 365 top, p. 366 and p. 367 reproduced from Colonial Office publication No. 182 'Agriculture in the West Indies')

Cape Province Pineapple Industry

The vicinity of East London and Bathurst in the Cape Eastern Province is now the most important pineapple-growing area in the Union of South Africa. During the last 12 years the area planted with this crop has more than doubled and stands at about 10,000 morgen at the present time. It is still increasing to fulfil the steady demand for pineapples for the canneries in Port Elizabeth and elsewhere. The bulk of the South African pineapple crop is canned and only the small surplus is offered on the fresh fruit market.

The Farming Picture in Tropical Africa

W. V. BLEWETT

The development of tropical Africa could be all important to Western Europe in its search for food, raw materials and overseas markets, but the dearth of agricultural specialists, particularly in the British Colonies, is severely hampering this work. The author, formerly consultant on tropical agriculture to Imperial Chemical Industries, Ltd., has recently completed a tour through many of the tropical African territories. He describes some of the things that are being done to develop the resources of these great areas. The article is a shortened version of a lecture recently delivered before the Royal Society of Arts.

THE value of agricultural exports from Tropical Africa is well over £100 million, to which the chief contributors are cocoa, cotton, groundnuts, oil palm products, tobacco, coffee, sisal and timber. The area of Tropical Africa is about 7½ million square miles. It lies south of the Sahara and north of the Union of South Africa. Its population is about 120 million, which gives a population density of 15 to a square mile.

It is, on the whole, a well-watered area with good rainfall and many large rivers. Areas with a high rainfall are covered with forests. Where there is a dry spell of a few months we find woodland or savannah. Areas where the dry period is much longer than the wet period are generally under grass; but some good rainfall areas are grassland.

There has been a strong reaction from the formerly held view that Tropical Africa is a land of abundant fertility, which may, however, have gone too far.

French West Africa

West Africa, which is largely French territory, is dominated by the Niger River. West of Timbuctoo is the interior delta of the Niger, where in the flood season a large area is inundated, and near here the French have started a large irrigation scheme. The Niger, depositing sediment as it goes, has built up its bed until it is several feet above much of the surrounding country, so that during the flood season it overflows a large area on the north bank.

Sansanding, an adjustable barrage costing £2 million, raises the level of the river several feet and directs much of the water into channels which link up with the ancient water courses to irrigate large areas. This Niger Irrigation Scheme has two objects: to grow food and cotton for the use of the increasing population of French West Africa and to produce rice and cotton for export. Today the total area of crops is only 24,000 acres of rice and 15,000 acres of cotton (mostly ' Allen ' with some ' Egyptian ' to the north), but the crop acreage is being increased by about 10-20,000 acres a year, after soil surveys have given reasonable assurance that soils are suitable. Yields of rice and of cotton are good, 900 lb. clean rice and 300 lb. lint per acre, and these can be considerably increased by the use of sulphate of ammonia.

The importance of mechanisation is appreciated by the French, who say: ' The machine gives Africa its chance.'

There are two types of enterprise at Sansanding: The Native Agricultural Association, which is a co-operative scheme, and Peasant Holdings, by which a small parcel of land (15 acres is a standard unit) is allotted to each family accepted as colonists, who are supplied with seed, cattle and implements, and with food until the first crop is harvested. The land is ploughed for them. No land can be sold. It is granted conditionally for 10 years. No wages are paid and the peasants must make their living by farming. They must also pay for all equipment and services. Europeans teach the colonists how to grow not only the main crops but food crops also. There are 2-3,000 Africans awaiting land—more than can be accommodated at the moment. The number of African workers is 4,000 (total population on the scheme is 17,000 in 49 new villages). The scheme has some serious handicaps, *e.g.* all oil, steel and cement come by rail 800 miles from the coast; but cement will, however, be manufactured locally.

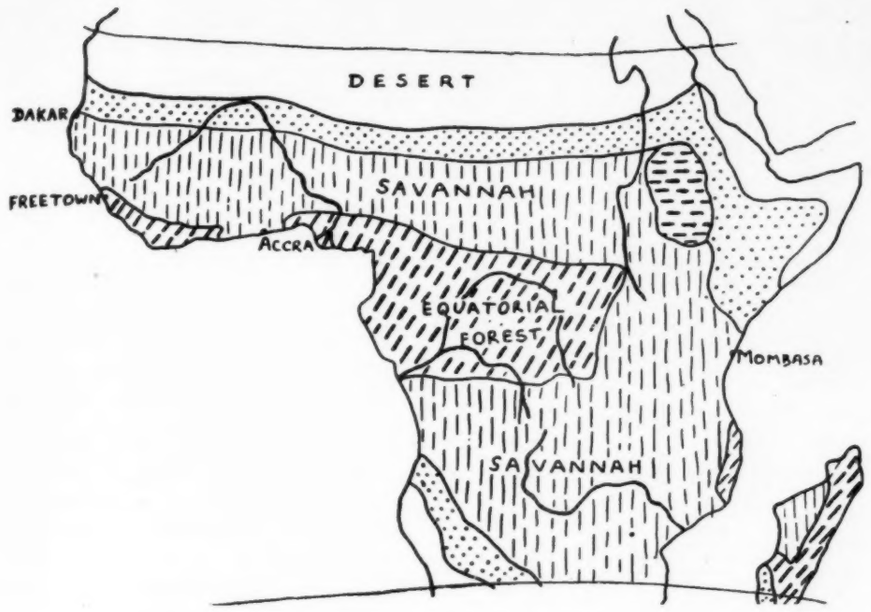
The Upper Niger

How will this affect the Niger lower down? The Niger, Senegal and Gambia rivers rise in the high country in French Guinea, and these areas were until recently heavily forested. Today they are being deforested and half a million people are living with their cattle in them. How long this can go on without serious damage to the Niger seems to be a matter for international study.

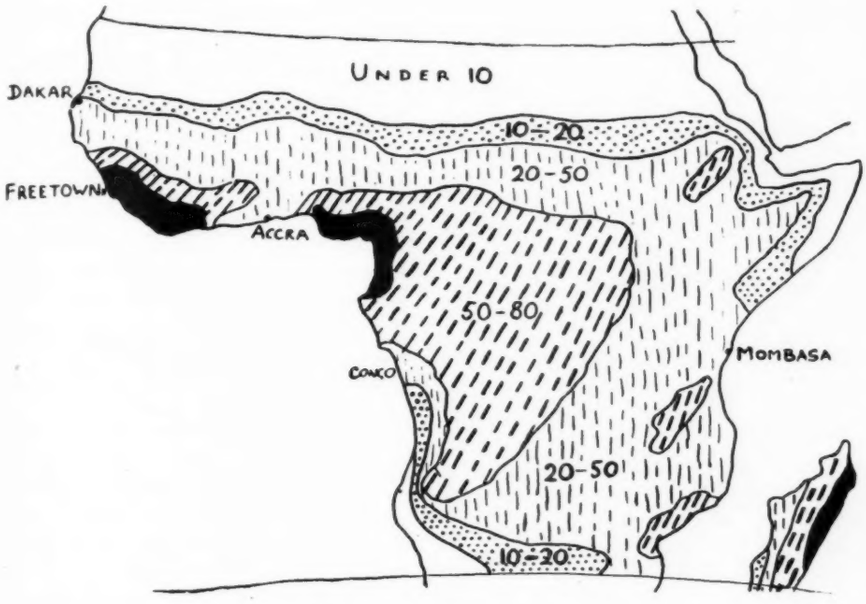
Senegal

There are the beginnings of a large irrigated rice scheme near Richard Toll on the Senegal River, which flows into the sea at St. Luis, but for only two months in the year. For most of the other ten months the sea flows into the river, the bed of which, for hundreds of miles, is lower than sea level. A scheme has been proposed for damming the Senegal River at two or more points, thus maintaining fresh water in the river the whole of the year and irrigating a large area (perhaps 2 million acres) of what is now practically a dry wilderness, on which food crops could be grown. This scheme is only in the ' blue-print ' stage.

Another scheme which has been started is in Casamance, a light forest area of good rainfall south of the Gambia. Here there are large salty or brackish creeks running many miles inland. It is proposed to reclaim these to grow groundnuts with the aid of machinery, rice, and also coconuts. The area at present being cleared is 75,000 acres, but the total scheme may run to 500,000 acres. Staggered windbreaks will separate the arable blocks of land, in West Africa the strong winds and long dry spell make windbreaks very essential.



Vegetational map of Tropical Africa



Rainfall map of Tropical Africa

French research

A word should be added about the scientific side of the work. Agricultural administration has its centre at Dakar, from which area all French West Africa is controlled from Dakar to Lake Chad. Agricultural research has its centre at Adiopodoumé in the Ivory Coast. At present this research centre is a humble group of primitive buildings but it will shortly become the centre for training agricultural specialists for all French tropical colonies in Africa, the Far East and the West Indies. There will be 30 to 40 French students. The staff today consists of about eight specialists; botanists, entomologists, soil scientists and mycologists. Situated in the coastal forest belt, Adiopodoumé is a good centre for research into the problems of the wet tropics for there are coffee, bananas, and cocoa plantations in the neighbourhood and a whole host of tropical crops can be grown on the typical, reddish, light soils of the forest areas.

British West Africa

The Gold Coast

The biggest project in the Gold Coast is the Volta hydro-electric scheme which, though primarily industrial, may profoundly affect the agriculture of the area. By raising the level of the river 200 feet in a gorge near Ajena, a great lake covering thousands of square miles would flood an area which is now largely swamp and uninhabited. The River Volta would be made navigable for nearly 200 miles up to Yegi, and this would have a big effect on the movement, and hence the production, of crops and would make irrigation feasible over a considerable area.

At Damongo in the north west of the Gold Coast there is to be a mechanised groundnut scheme, which is to start with a pilot scheme covering 12,000 acres. Other crops which are under consideration are guinea corn and fibre crops (Hibiscus and Urena). This scheme will be run by the Agricultural Development Corporation, which is a Gold Coast Government organisation.

One can hardly refer to the Gold Coast without mentioning cocoa, which is entirely grown by Africans and covers 1¼ million acres, and which brings in annually £20 million, *i.e.*, nearly two-thirds of the income of the colony. The damage already done by 'swollen shoot' in part of the cocoa area should not make us conclude that the industry is already doomed. Given co-operation in the drastic cutting out of the infected trees, which is at present the only known remedy, swollen shoot should be kept within bounds though not eradicated. Much research work is going on and very promising new types of cocoa trees are now being grown on an experimental scale, but the research station is still very short of staff.

Nigeria

Nigeria has a ten-year plan which is estimated to cost £55 million with many development schemes, but only 30% of this is to be spent on agriculture. Being a large country running several hundred miles inland it has a wide range of climates and crops, from wet equatorial forests near the coast to thorn-trees and grassland (savannah) in the north.

Groundnuts. The export of groundnuts from Nigeria is 300,000 tons annually, grown by Africans on small plots in the north. Nigeria now has a mechanised groundnut scheme on a moderate scale at Mokwa, which has been promoted by the Colonial Development Corporation, and is known as the Nigerian Agricultural Project. Clearing began last year and the first crop

will be grown this year—3,000 acres, the first part of a pilot scheme of 25,000 acres. It is known that groundnuts grow well in that area and respond to superphosphate. The crop rotation has yet to be decided. Sorghum will be grown the first year, followed by groundnuts. Clearing the bush has been done inexpensively by local contract, using only hand labour at a cost of about £3 10s. 0d. per acre.

Oil Palms. The oil palm is of first importance in Africa; it grows from Sierra Leone across coastal West Africa and through the Congo forest areas. The annual export from Nigeria alone is 125,000 tons of palm oil and 350,000 tons of palm kernels, worth over £7 million, and the oils are very necessary to us in this country for both edible fats and soap.

An acre of groundnuts gives about 3 cwt. of oil, but an acre of oil palms on the best estates in Malaya gives 30 cwt. In Nigeria oil palms grown by the African give not more than 3 cwt. of oil per acre, but European plantations give about four times this; as a result of the research being carried out in Nigeria, production per acre will be greatly increased. The United Africa Company has 35,000 acres of plantations in Nigeria, of which more than half are oil palm. The Nigerian Department of Commerce and Industries is erecting pioneer oil-mills for the extraction of oil from the fruit of the oil palm. This scheme also will be run for the benefit of the African; and if it is combined with the planting up of better quality palms, it should have important results on the Nigerian economy.

Rice. The 1948 Rice Commission reported on the rice-growing possibilities of West Africa and optimistically concluded that 2 million acres producing 2 million tons of paddy rice could be brought under production in ten years. Of this, 1,600,000 acres were in Nigeria. In the Sokoto area, mechanised rice-growing has been started and other schemes are under consideration but require detailed surveys.

British Cameroons

The most important crops in the British Cameroons today are bananas—4 million stems were sent to Great Britain last year—and cocoa, the area of which, it is said, could be doubled to make 120,000 acres. There are good grassland areas and tea can be grown.

Summary of West Africa

Summarised impressions of West Africa are as follows:

(1) Agricultural production could be vastly increased.

(2) Large areas have good soils and much of it is underpopulated.

(3) The British have failed to make use of the possibilities for irrigation and have failed to teach the African to do so. This is surprising in view of experience in India and in Egypt.

(4) Africans have shown that given the incentive they can adapt themselves to new crops.

(5) Nigeria is ahead of other British dependencies in development schemes but in no territory have the British solved what Lord Hailey called the most urgent problem, *viz.*, the introduction of methods which will maintain fertility without recourse to shifting cultivation.

Belgian Congo

The Belgian Congo is over ten times as large as Great Britain with a population of 12 millions, of whom 45,000 are Europeans. It is blessed with amazing mineral wealth, great areas of good rainfall, the best waterway in Africa, and not inconsiderable areas with a climate suitable for European occupation. The Belgians are making a great effort to study the agricultural possibilities of their wonderful colony. Their problem, too, has been how to maintain the fertility of the light soils of the forest areas. They started off using European methods—ploughing, clean-weeding and thorough cultivation—with disastrous results. Much land in the lower-rainfall areas that was under forest until recently is now grass. Now they claim to have discovered in their ' Corridor System ' a striking improvement on the African's shifting cultivation.

This work has been done largely at Yangambi, the headquarters of the Institut National pour L'Etude Agronomique du Congo Belge (INEAC), which is quite independent of Congo's Department of Agriculture, and is directed from Brussels.

The soils at Yangambi are light, sandy and deep—of *p*H4 on the average. They are undoubtedly fertile and give big yields of upland rice, cassava, groundnuts, etc., though they rapidly lose their productivity under cultivation. Strangely enough practically nothing is known about the value of fertilisers and the part they might play in maintaining fertility. At present after only three to four years of cropping the soils must go back to forest for many years. If this could be avoided, the productivity of the land could be greatly increased. Of crops recently developed, pyrethrum quinine and urena fibre are regarded as promising.

Much of my short stay in the Congo was taken up visiting INEAC research stations and the oil-palm plantations of the Huileries du Congo Belge (a subsidiary of Unilever). The H.C.B. have about 140,000 acres of plantations in the Congo—mostly oil palm—and here again they have played a leading part in the development of oil-palm plantations and extractions of palm oil.

In the well-watered country, paddy rice—as distinct from upland rice—could be grown widely, but Belgium fears that malaria may be troublesome if rice is grown on a large scale in swampy country, though rice-growing combined with fish ponds is being tried. Cotton is an important crop in north and in central Congo. Pests are common on both cotton and coffee, and six helicopters have been used to carry out spraying and dusting from the air.

The Corridor system

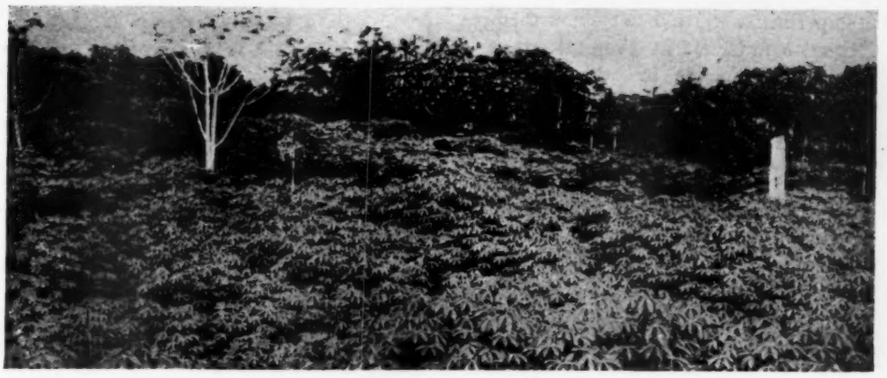
The Corridor system is primarily intended to increase food crop production while avoiding the damage to the soil which results from unsound methods.

The corridor system in the Belgian Congo. Note the forest belts on either side of the banana plantation

There are two principles to be observed in tropical cultivation of light forest soils: First, they must be protected from the sun as much as possible and be stirred or dug as little as possible; and secondly, the plants must receive the maximum amount of light, for on the Equator, with its short day, light is a limiting factor. Furthermore, conditions should be favourable to forest re-establishment as soon as cultivation ceases. These principles are put into practice by clearing and cultivating narrow corridors running east and west, so as to be exposed to the sun all day; by growing mixed crops (giving good soil cover or shade) as much as possible; and by planting, towards the end of the cultivation period, crops which favour the return of forest plants. The total period of cultivation after clearing is three to four years. These corridors are 100 metres wide and a mile or so long. Next to a cultivation corridor is a forest belt of 100 metres, then a cultivation corridor and so on. By having several of these in a block to be worked from one African village, there will be time for the first corridor to have been under forest for say 12 to 15 years after cultivation, before it is again cultivated.

The crops which are most destructive of soil organic matter and structure are the cereals, chiefly maize and rice, which, however, must be grown in order to supply food grains. They are grown in the early part of the three to three and a half years of corridor cultivation and are followed by beans, cassava and bananas. But several other crops are grown in the mixed cropping, *e.g.*, tobacco, soya, sugar cane, and groundnuts. Soil cultivation should be reduced to a minimum. Forest soil temperatures are about 75° F., while exposed soils in the open reach 100° F. and over—hence the importance of keeping the soil shaded. Most of the year soil moisture is not a limiting factor, but January-February are comparatively dry and during this period maize is grown, as it stands the drier conditions better than other crops. Yields are said to be good—upland or dry rice 1,000 lb. per acre of clean rice, cassava 12 tons; the yield of groundnuts was also good. By the time the bananas and cassava are being harvested the forest growth is coming back. If abroma, a fibre crop, is grown as a final crop this facilitates the return of the forest. It has been found that the narrower the corridor the more quickly the forest regenerates, growth of the parasol tree being frequently so thick that it looks like a thickly sown plantation.

The system carries with it the assumption that forest fallow cannot be dispensed with and must occupy the land for say 80% of the time.



Native cassava cultivation under medium rainfall conditions

The European Settlement

Grassland areas are extensive on the eastern side of the colony, and there are considerable possibilities for European occupation, the climate being similar to that of the Kenya Highlands. Farms of about 60 acres are being taken up by Europeans, growing chiefly coffee, quinine and pyrethrum. The chief difficulty is the lack of labour.

East Africa

African peasant settlements

Lack of space precludes discussing developments in East Africa and the Rhodesias, but I want to refer briefly to African peasant farming developments. In several areas the right balance of crops and the correct rotations to employ are being investigated and numerous schemes are being tried out.

For example, in Kenya may be mentioned the scheme for developing about half a million acres as a peasant settlement at Makueni south east of Nairobi with an average rainfall of 20 in. The area was formerly infested with tsetse fly and rhinoceros.

A thousand rhinos were shot; the tsetse is being controlled by selective clearing of trees. If this settlement scheme is successful, it will be an outlet for a neighbouring overcrowded African reserve. About 15 to 18 acres are allocated to a family, and the occupier has to carry out instructions as to the crops to be sown, the silage to be made, and the farmyard manure to be produced. At first there was a very poor response to the appeal for farmers, but last year the position changed and the Africans were coming forward more quickly than the land was being made available.

Reserves

Another aspect is communal forming in African Reserves. These cover a great part of the southern and eastern colonies of British Africa. At Chidugu Reserve south of Salisbury, Southern Rhodesia, contouring, use of farmyard manure and compost, and rotation of crops were being carried out with considerable success, and the evidence of co-operative effort was most encouraging. There is no doubt that some form of group farming, as it is called, will be the best way to tackle many problems including maintenance of soil fertility and soil conservation.

Fertilisers

The consumption of artificial fertilisers in Tropical Africa is almost negligible, except for Southern Rhodesia, which uses about 40,000 tons, mostly for growing tobacco. One reason why usage has been so small is that it has been generally believed that if new methods of fertilisation are to win their way they must be adapted to the financial and labour resources of the average African farmer and it would seem therefore that they must be based on natural processes rather than on the use of artificial fertilisers.

As almost all countries have gone through that stage, it is not surprising that Tropical Africa should do so. Most agricultural processes, such as ploughing the soil or milking a cow, are quite unnatural, and it is strange how strong the objection has been in many countries to the use of fertilisers on the grounds that they are not ' natural.' The chief reason why fertilisers have not been used in Tropical Africa is that they have not been really tried, but have been rejected on the grounds that they would be too expensive or likely to be ineffective.

Imported fertilisers were regarded as so costly that only exceptionally large increases could be of economic value, but in 1946 an extensive rock-phosphate deposit was opened near Tororo in Uganda, and the possibility of obtaining cheap nitrogenous fertilisers, using cheap power available at the Ripon Falls near Jinja, was outlined in development plans.

Experiments carried out show that response to fertilisers in Tropical Africa is much the same as in other countries. Crops known to respond include maize, sorghum, groundnuts, rice, sugar cane, bananas, yams, cotton, tobacco, wheat and beans. The plant foods needed are chiefly nitrogen and phosphate. Some countries have been very backward in carrying out experiments, *e.g.*, the Belgian Congo and the Gold Coast, and no experiments have been done on cocoa.

Perhaps the most important crop in Tropical Africa is grass. It grows luxuriantly in the wet season, but there are no clovers (except in the Highlands) to supply nitrogen as they do in temperate climates, so that the need for fertiliser nitrogen is more marked.

Work with fertilisers on tree crops is notoriously difficult and this seems to be especially so with oil palms; experiments, however, seem to indicate that potash increases fruit and oil production.

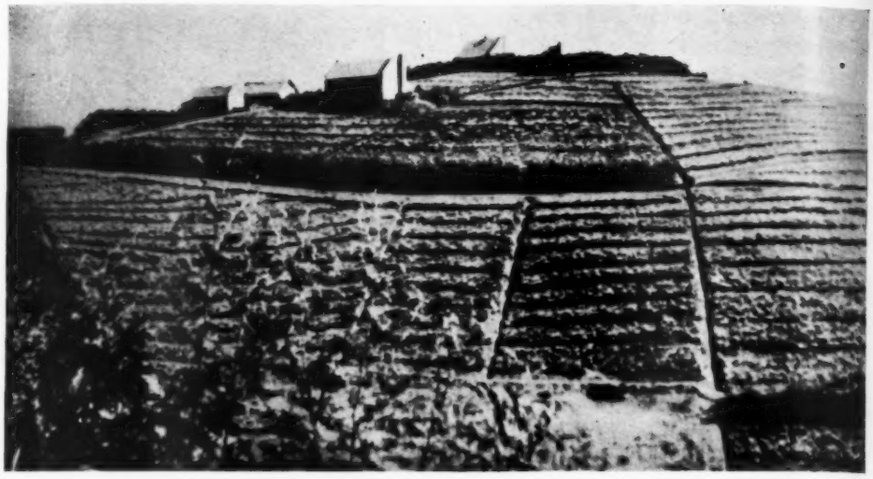
Experimental difficulties

Fertiliser experiments in the tropics are more difficult than in this country. Terrific downpours of rain wash away fertiliser plots unless sites are carefully chosen and protected. The nitrate content of the soil varies enormously from time to time, and the timing and number of applications of nitrogen fertiliser need study. Contouring and ridging may be at times more important than the fertiliser and must not be neglected. Sometimes organic matter must be supplied liberally to the soil. On the other hand it has been shown in Northern Nigeria that the value of farmyard manure depends entirely on its plant-food content and can be more cheaply replaced by a small dressing of fertilisers.

To sum up, no one who has studied the response to fertilisers in various parts of this area can doubt that they can increase yields by 30 to 40% in the better rainfall areas, and may play an important part in helping to maintain soil fertility for an indefinite period. Is it not strange that, at a time like this when people are talking about the over-population and undernourishment of Africans and asking whether Africa can feed herself, that fertilisers in most areas have hardly been tried?

Difficulties in practice

There are many difficulties in the way of agricultural development; perhaps first, the lack of railway and roads. Next is our ignorance of many problems. European methods of agriculture proved more dangerous than those of the African, for the European assumed that methods suitable for temperate regions could be adopted in the tropics, and he used machinery to ruin soils where the African used only hoes. The great importance of protecting certain soils from the effect of the sun in order to conserve moisture, humus and structure was unknown. We now know that clean-weeding or lack of contouring, while allowable in England, can be very dangerous in Tropical Africa. But the African has adopted ridging and mounding of the earth for his crops over most of Tropical Africa. Is he right? His methods of mixed cropping seem to be more sensible than they look and they certainly protect the soil from the sun. Again, he has in Nigeria picked out a shrub (Acioa) for use in restoring fertility to an exhausted soil. We have failed to produce new and improved varieties of sorghums and yams and many other food crops. Only in Southern Rhodesia have we started work on hybrid maize, though in the U.S.A., as in Southern Rhodesia, the crop is increased about 30%.



Soil conservation in the Belgian Congo showing contour terracing

There are far too few agricultural workers in African colonies. Agricultural officers often have areas that are much too large and with few roads. We in Great Britain have not realised the value of trained tropical agriculturists in the British African colonies.

All those who have visited West Africa with a knowledge of other agricultural areas have been shocked at the general lack of staff and of effort.

The most striking and most recent report, covering almost all the British Colonies of Africa, is that of the 'Three Wise Men,' as they are called, three U.S.A. experts who visited Africa in 1949 in accordance with President Truman's suggestion that America should help in the development of backward areas. While their report is very courteously and modestly worded, they make it perfectly clear that the agricultural effort in these colonies is but a fraction of what they consider necessary.

We have new weapons these days, insecticides, weedkillers and pharmaceuticals. Each victory with new weapons brings new problems and demands more trained men. Large numbers of Africans come or are sent to England to be trained as lawyers, doctors, and engineers; how few come to be trained as agricultural officers. Great Britain must regard more seriously the problem of how best to develop agriculture in the colonies, for on that depends not only the export of foodstuffs and raw materials to European countries, but the very future of the colonies and the well-being of the African peoples.

London should be the great world centre for tropical agriculture. It must have a School of Tropical Agriculture (as it has a School of Tropical Medicine) which will be a clearing house for information and a centre for the higher training and research refreshment for tropical agricultural workers; not that tropical agriculture in all its applications can be taught in London. For *that* agricultural colleges must be established in Africa similar to the one in Trinidad—one in the West and one in the East—where European and African can carry out research and experiments under the finest leaders that can be found in the world.

The way to solve the specific problems of tropical agriculture is to establish on the spot teams of research workers, working without interruption, and to create such organisation as is needed to put their solutions in practice.

Is it too much to hope that we shall have in the near future a greatly enlarged staff of agricultural specialists who, like the French and Belgian specialists, will have been trained in Tropical Africa?

The World Problem of Erosion

Soil Conservation Machinery

Part II

P. H. SOUTHWELL

Last month the author discussed types of machinery suitable for carrying out conservation measures on comparatively level land. In this concluding part of his paper machinery for use on undulating and sloping land is described and some account is given of contour farming and terracing.

Contour farming

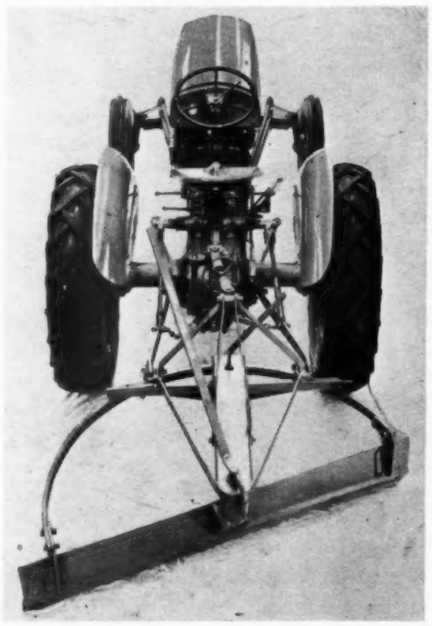
IN areas of moderate rainfall, on gently rolling land, strip-cropping is normally part of the practice of contour farming. Grassed waterways are often provided for water disposal and contour furrows may also be used to catch and hold rain and prevent run-off.

Permanent grassland can be furrowed on the contour but special equipment is needed unless reseeding is permissible. In the latter case the furrow can be made by a ridging body or a one-way mouldboard plough making two cuts, the second deeper than the first, or by a single-furrow disc plough with an extension mouldboard to move the furrow slice over.

It is, moreover, possible to cut the furrow without ruining the turf. One machine consists of an ordinary plough frame with a V-shaped blade for cutting loose the furrow slice, and bent steel rods for lifting and guiding this slice over to the lower side of the furrow. Another blade cuts off a strip of turf which is transplanted on the furrow slice and pressed down by a slightly concave roller. This machine needs tough grass and absence of stones so that a continuous strip can be maintained; it is very useful on steeper slopes. A second type of implement cuts and lifts two wide strips of turf and a furrow is made in the subsurface soil by a disc plough before the strips are rolled back and pressed into place.

Terracing

Terracing is one of the leading methods of combating soil erosion and machinery for building and maintaining terraces is essential farm equipment in some regions. The Soil Conservation Service of the U.S.A. has adopted a standard terrace width of 24 ft. and a height of 18 in.; this means that some earth will have to be moved about 12 ft. longitudinally (if the terrace is built from both sides) and lifted about 18 in. on the upper side and considerably more from the lower side. The primary requirements of a terrace building implement are therefore that it can move and lift earth with the minimum of effort at the maximum speed. Further operational requirements are that it should be robust and capable of turning sharply at the ends of terraces, yet following well on sharp curves; adjustment must be rapid and provision made for side thrust when working on the side of a terrace ridge.



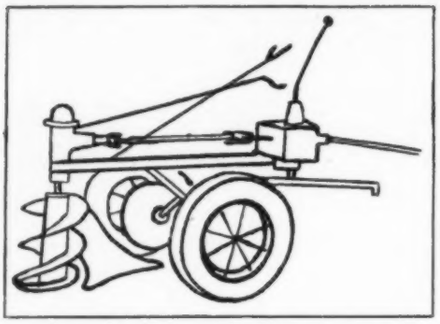
Small blade terracer mounted on a light wheeled tractor

A wide range of implements has been used for terrace construction varying from home-made V-drags to heavy specialised road graders. Terraces can indeed be built with ordinary mouldboard and disc ploughs although the quality of this work is very dependent on the operator and time and labour requirements may be excessive. Supplementary extensions for mouldboards are sometimes used to move soil higher and further, but loss of penetration and danger of overloading the beam may result. Especially designed terracing ploughs to overcome these factors are available and are often preferred to disc ploughs. The latter do not move soil so great a horizontal distance and may be awkward to handle on a ridge, but a single disc lends itself to integral mid-mounting on a tractor—an arrangement very suitable for terracing.

In constructing a ridge-type terrace earth is moved towards the centre by ploughing to a ridge furrow until the desired width is obtained, height of ridge and depth of channel being obtained by repeated ploughing. The size of terrace and capacity of channel must be such as to withstand contoured cultivation and still convey the load without breaking. In a channel-type terrace soil is moved outwards, ploughing being started at the outside and finishing in the central water furrow. Although ploughs have a low first cost and are normal farm equipment, their use for terracing has the disadvantage that the process is slow and the procedure may have to be repeated several times after allowing the ground to settle. There is also the risk that heavy rain may wash out sections of the terrace before completion. V-drags are often used in conjunction with ploughs to speed up the work.

Blade terracers

Probably the best known implement is the blade terracer or grader, which can also be used for earth levelling and so forth. It was developed from the blade type of road grader but it has been found that operating conditions on rough land generally necessitate a more rigid frame. Unmodified road graders have been used effectively when sufficient power was available but they have the two practical disadvantages of a considerable turning circle and difficulty of control on sharp curves. Small blade terracers capable of being hauled by an average farm wheel tractor are available but many are too light to work well on hard soil or rocky land and



Sketch of a whirlwind terracer

there is often insufficient provision for side-thrust, although a pivoted hitch facilitates adjustment.

The general properties of a terracer are important, as they effect stability and smoothness of operation on uneven ground. In a two-wheel terracer the front support is on the tractor drawbar; this improves manoeuvrability, while a wide track with short overall length increases stability; however, the width must be narrow enough and length sufficient to minimise the effect of tractor oscillations. A low centre of gravity is desirable but there must be sufficient clearance for the blade control mechanism.

Penetration of the blade is mainly by weight of the machine and the cross-section of the blade often has the form of an arc of a circle to produce a rolling motion, thus leaving the soil in a compact mass and avoiding pulverisation. On some soils a blade length of 10 ft. or more is used to move the soil the required distance and yet retain enough angle to scour. Blade control is normally secured by reversible worm gear operated from a platform at the rear of the machine. The blade supports are on a circle and can be turned, raised or lowered and tilted. Provision is also usually made for reversing the blade (*i.e.*, to work to either side), altering the pitch and moving it sideways on the frame when the machine is in motion, so that soil can be placed with advantage on sharp curves.

A combination of track-laying tractor and blade terracer has been widely used, the tractor helping to overcome side-draft; it gives a compact terrace and allows other essential work such as the construction of grass outlets to be accomplished. For small fields and rough slopes a two-wheel machine is often preferred, but on large fields and gentle slopes a four-wheel grader is usual. The obvious choice of tractor for this work is the track-laying type (with plenty of front-end weight when used with two-wheel terracers), but for efficiency the power of the tractor and the capacity of the machine must be compatible.

Elevating terracers

One criticism of the blade type terracer is that it is not very efficient for moving earth and a logical development is the elevating terracer in which soil is cut and delivered to a conveyor belt by a blade or large disc; the conveyor both lifts and moves the soil longitudinally onto the terrace ridge so that the required height is easily obtained. This type of machine works well in dry soil without stone and produces a good terrace cross-section. The capacity of the conveyor is usually limited by the performance factor but the machine is speedy, although expensive and rather complicated.

Whirlwind terracers

The whirlwind or rotary terracer throws the soil on to the ridge instead of transporting it by a conveyor mechanism, and therefore requires less power, the rotor being driven from the tractor power take-off like the conveyors on many elevating terracers. Early types consisted of a plough with shortened mouldboard behind which a driven helical rotor was fitted. This rotor is normally driven through a two- or three-speed gearbox and its right-hand side is in line with the right-hand side of the share edge so that it is not cutting unloosened soil; the short mouldboard lifts the furrow up into the rotor which throws it to the side. The pitch of the rotor is usually from 6 to 14 in., and with the higher pitch it is necessary to tilt the rotor in order to achieve the required elevation. Furrow slices may be up to 18 in. wide and 12 in. deep and the throw may be as much as 20 ft. at a height of 2 to 5 ft. A disc is sometimes used to cut the furrow, and disc wheels on a telescopic shaft may also be employed to stop the earth throw and build the terrace more quickly.

This type of implement can be operated by a medium-wheeled tractor and is very speedy; it leaves a ridge of pulverised soil ready as a seed bed, which may be a doubtful advantage in some areas as the ridge takes a long time to settle. The machine is manoeuvrable on terrace bends, needing no adjustment, and will work well on soil too wet for normal tillage if free from rock or gravel, but not so well on dry soil or steep slopes. It is also well adapted for making ditches and outlet channels more than 4 ft. wide at the bottom.

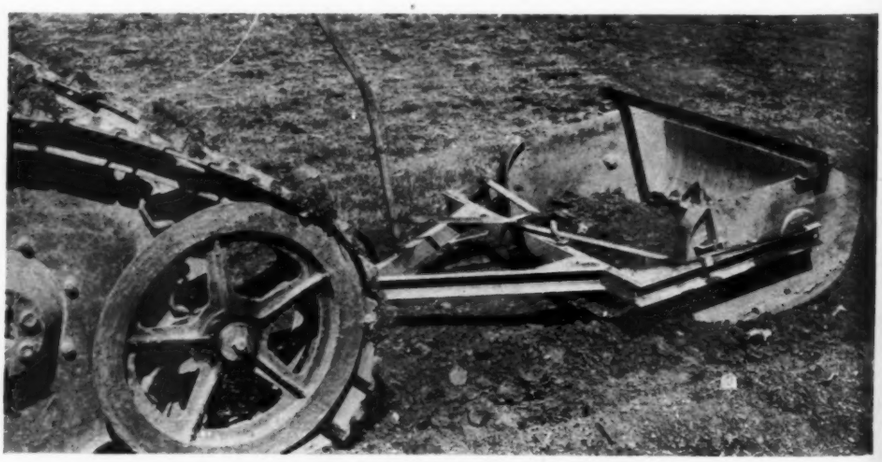
A terrace built with any of the above-mentioned machinery may need grading, and it is especially necessary when working over gullied land to fill in low places on the terrace and reduce high spots in the channel, the point being that no terrace is better than its lowest point.

Terraces are worked down by any cultivated crop and must be maintained. It is obviously sensible to move soil from the channel to the ridge with any of the simpler implements in normal farm employ, *e.g.*, mouldboard or disc ploughs, V-drags or light blade terracers. One-way mouldboard ploughs are popular in some districts for both terrace cultivation and maintenance.

Structural methods of conservation

In addition to cultural and tillage methods of soil conservation it is often advisable and necessary to provide structural protection especially on very steep slopes and in regions of high, concentrated rainfall by the construction of bench terraces.

They require considerable manual labour, and bench terraces are usually built up over a number of years, but they can be formed in a comparatively short time by concentrated effort. In the latter case, machinery can sometimes be used to supplement manual labour but only on the more moderate slopes. It is preferable to begin construction at the bottom of the



Tractor hauled scoop or slip scraper

slope so that top soil is moved from a terrace to cover the surface of the one below, and this operation can be assisted by the use of tractor-mounted ploughs angle-dozers and terracing blades

On the wider terraces it is possible that small elevating terracers and disc ploughs can be utilised, but machinery more positive than a whirlwind terracer is required. Probably the most suitable equipment is a track-laying tractor with an angle-dozer mounted at the front for use in moving soil from the upper terrace to the lower and for levelling the earth so deposited. Whatever the choice of machinery, there must be room for manoeuvring, and the stability of the machine on the slope and the terrace under the weight of the machine must be taken into account. Attention must also be given to the prevention of erosion on the pathway left for descent of the machinery when the project is completed, which may be retained for the subsequent ascent of terrace cultivating equipment.

Light model bulldozer at work, mounted on the front of a medium size farm tractor

Tractor mounted scoop

Water channels

Diversion channels with a ridge on the lower side are built across slopes to carry water run off; they are sometimes known as storm drains and are designed for use on land which may be subject to uncontrolled flood water from unprotected lands above. Terrace outlets are a critical section of any project because erosion in the outlet may convert a terrace system into a gully system by permitting too rapid flow of water into the run-off channels which finally dispose of it.

Diversion channels and terrace outlets may be constructed with most of the machines for building broad-base terraces, for instance ploughs, blade and whirlwind terracers. The former are sometimes built rather deeper than the latter and special heavily-built ditching ploughs may be used. Erosion control in terrace outlets may be by vegetative cover or by mechanical works; in the latter case the foundations for spreaders and boundary levees can be made by small trench diggers, while bulldozers, fresnos and slip scrapers are also used in their construction.

A run-off channel is usually in the form of a ditch, and conventional drainage equipment such as trench diggers, excavators, grabs and draglines is used. Where this is not available certain terracing equipment, notably the whirlwind terracer, may be utilised in suitable soils.

Gully control

Apart from vegetative means, the spread of a large gully can be checked by the construction of dams across it, by a diversion channel to conduct water away from the head and/or by reducing the slope of the sides. The latter operation may be carried out by a plough, terracing blade, bulldozer or similar earth-moving equipment depending on circumstances, so that soil is pushed into the bottom of the gully which may then be built up into dams.

Small numerous gullies on a slope are probably best dealt with by filling in with a bulldozer, levelling blade, fresno or slip scraper, followed by terracing.

Dams and ponds

Equipment for the building of ponds (for which a large gully may form the basis) or dams, ranges from drag pans to heavy scrapers towed by track-laying tractors. Both ponds and dams help to decrease the rate of flow from a water shed and thus prevent flooding in lower areas, but adequate spillways must be provided. Much of the equipment required has been mentioned earlier in this paper; it includes bulldozers, front- and rear-mounted tractor scoops, etc., for the construction of dams, and bulldozers, fresnos, slip scrapers, terracing machinery and so forth for the excavation of ponds.

The bulldozer or angle-dozer is normally mounted with hydraulic control on a track-laying tractor, but smaller models are available for attachment to the front-mounted loader framework built for average wheel tractors to take muck loaders, scoops and hay sweeps.

Shelter belts

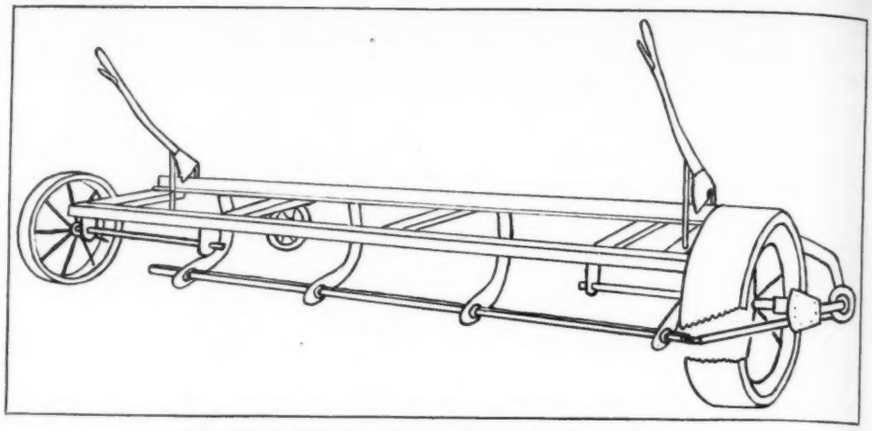
The planting of trees to form shelter belts or windbreaks provides valuable protection on open plains or other areas subject to wind erosion. Auger type post-hole diggers are sometimes used in planting young trees on grazing land but, less laboriously, mechanical planters developed for afforestation facilitate the work, particularly on cultivated land.

Most mechanical tree planters form a trench and the earlier types consisted of a ridging-type plough body with attachments to wedge the soil laterally, followed by a heavy press wheel to pack the walls of the trench after planting. This was not very good for the plant roots and sometimes resulted in incomplete closure on stiff land. Modifications include discs to spill loose earth into the trench before pressing, and inclined flanges to raise the soil slightly before wedging so that it falls back more easily. A more recent development consists of a heavy ridging plough with a disc coulter in front, a planting shoe behind and provision for elevating the soil so that it spills outside, followed by cover plates to bring the soil back after planting the trees. The system not only favours root development but requires less power than lateral wedging. The type of shoe and plough-shoe assembly depends largely on the type of soil, and the efficiency of these machines upon the land not being too stiff or too steep, and on its freedom from rocks and stumps.

Machinery in conservation practice

A conservation programme naturally gives rise to new conditions of operation for farm machinery. Contour strip cropping may entail a decrease in the average size of fields and an increase in their numbers leading to fields of long, narrow and irregular shapes, and may cause an increase in the overall power requirements. Moreover, greater flexibility, greater manoeuvrability and ease of operation combined with high accuracy in implement control is required. In contour work mounted implements should be located as near as possible to the tractor centre and trailed implements should be closely coupled; the operators must watch the implement more closely than when working in straight rows, and frequent adjustments of depth are necessary on uneven ground. In contour farming accordingly there are a greater variety of jobs to be done, but probably a lower percentage of these have a high power requirement; in these conditions two small tractors will probably often be more useful than one large one.

Terracing requires earth-moving equipment for use with average farm tractors, while the existence of terraces produces conditions which considerably affect machine design. Thus in a terraced field a part will have its original slope, a part will have a steeper slope in the same direction while another will have a slope in the opposite direction. From the conservation viewpoint it is essential to farm parallel to the terraces, and consequently a machine must have enough flexibility to work efficiently both on the terrace ridge and in the channels. Positive steering and minimum creep of wheels are also very important when working row crops on steep slopes and on loose soils, and it is preferable to select implements of such widths that tractors are not required to run on the steepest part of the ridge.



A typical rod weeder with land wheel drive

(Photos: p. 375 and p. 377 lower, Harry Ferguson, Ltd.; p. 376 and p. 377 top, N.I.A.E.)

Rockefeller Aid to Mexico Shows Results

The recently published Review for 1949 of the Rockefeller Foundation carries a description of work in progress directed towards the improvement of Mexican agriculture. The joint agricultural programme of the Foundation and the Mexican Government has been under way since 1943 and it is claimed that employment of modern science and technology is now resulting in improvements in both the quantity and quality of the output of Mexican farms. It is expected that the expanded agricultural production will step up the whole Mexican economy in years to come.

Each of the collaborators has contributed heavily to the operating costs of the programme. Nearly a million pesos have been allocated by the Mexican Government and the Rockefeller Foundation has so far granted 1,317,155 dollars. The Foundation believes that the returns derived from these investments are already considerable, and it is claimed that in six years the agricultural experts appointed by the Foundation working with Mexican scientists have materially helped Mexico towards the attainment of self-sufficiency in the production of corn and other staple foods.

The headquarters of the field research programme is at the central experimental station in the grounds of the National College of Agriculture at Chapingo, a few miles east of Mexico City. Here there are well-appointed laboratories and experimental fields, with a full complement of technical and lay staff.

New varieties of wheat and corn are stated to have been developed by geneticists working in conjunction with plant pathologists, entomologists and soil experts, which, it is claimed, combine higher yields with resistance to disease and suitability to Mexican conditions. These improved varieties have been called Rocamex grains.

Methods are also being worked out for rejuvenating exhausted soils by means of crop rotations and green manuring. In a country where commercial fertilisers are both scarce and costly great importance is attached to this. The replacement of the traditional native Mexican agricultural implements is also in progress.

It is hoped that in a few years many Mexican scientists at present working under the direction of the Foundation's officers, will be fully trained and able to take over the programme themselves, when the project will be entirely Mexican.

National grain commissions are now distributing the improved grain varieties as fast as supplies become available, and this policy has already benefited several thousand farmers. An indication of the effectiveness of the programme is the fact that in 1948, for the first time in 35 years, Mexico did not need to import any corn.

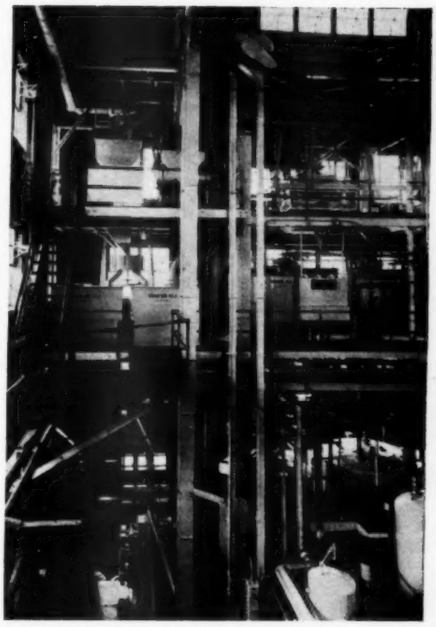
Alcohol and Agriculture

The production of alcohol from vegetable materials is an age-old industry dating back almost to the dawn of history. Apart from its traditional use as a beverage and a stimulant, as the sciences of chemistry and medicine have developed ethyl alcohol has found increasing uses as a source of raw material for the preparation of other compounds—as a therapeutic aid, as a solvent in manufacturing processes and as a means of generating heat and power. Indeed today the industrial uses of alcohol considerably exceed in volume the total consumption as a beverage and a stimulant. The industrial production of alcohol is a great industry which is largely fed with raw materials derived from farm produce. In the following paragraphs the principal sources from which alcohol is derived are discussed and described, and the future development of the industry considered. The article is based upon a recent publication of the United States Department of Agriculture.*

ETHYL ALCOHOL, commonly known as 'grain alcohol,' is, perhaps, the most universally known chemical compound that is manufactured. Chemically, ethyl alcohol (ethanol) is one member of a series of related substances (alcohols), other commonly known members of which include 'wood' alcohol (methanol), isopropyl alcohol (isopropanol), butyl alcohol (butanol), and amyl alcohol (pentanol). These compounds all have a definitely related chemical constitution or structure, but differ by the number of carbon atoms in each—C_1=methanol, C_2=ethanol, C_3=propanol, C_4=butanol, C_5=pentanol and so on.

These alcohols are produced commercially from different raw materials and by different methods. Methanol originated commercially from the destructive distillation of wood (hence its former name) although now it is principally produced synthetically from gases. Likewise, ethanol, isopropanol, and butanol now are largely chemically synthesised from certain hydrocarbon gases such as occur in natural gas or in the gases evolved from petroleum refining. Of the alcohol series, only ethanol and butanol (and some pentanol) are produced commercially in significant amounts by fermentation processes based on sugar or starch (carbohydrates). All of the lower carbon members of the family are now produced commercially to a large extent by synthesis.

Although ethyl alcohol is now produced from many types of raw materials and by diverse methods, until about 1929 it was produced commercially in the United States only by the fermentation of starch or sugar. In recent years it has been losing some of its former industrial importance because of competition from methanol, isopropanol, butanol, and other alcohols or derivatives thereof, legal restrictions surrounding its use, the relative costs of production and its relative value for specific uses. However, because of its manifold uses and applications in industry, commerce, medicine and the home, both as a chemical agent and as a beverage ingredient, ethyl alcohol continues to be a very important chemical commodity. It is marketed in many forms, ranging from pure and practically anhydrous alcohol to solutions or mixtures containing various (and often relatively small) percentages of spirit.



Grain receiving elevating and milling equipment. The grain handling equipment is on the left; on the right is a pressure cooker, particularly applicable to potatoes

Saccharine materials

The raw material used for the bulk of pre-war industrial alcohol production by fermentation in the United States was molasses, imported from the Caribbean areas. Before 1935 this consisted largely of so-called blackstrap, which occurs as an inedible by-product from cane sugar manufacture, about 45 gal. being obtained for every short ton of sugar produced. Blackstrap molasses contains about 50-55% of fermentable sugar, consisting mainly of sucrose (cane sugar) and invert sugar (glucose-fructose mixture) in varying proportions (usually about 70% sucrose and 30% invert sugar).

Subsequent to 1935 so-called high-test molasses has been used extensively for alcohol production also ; this is a product of cane sugar which has been partly hydrolysed, usually by acid treatment, containing 70-78% of total fermentable sugar, mostly invert sugar.

Under certain conditions it may also perhaps be economically feasible to produce industrial alcohol by direct fermentation of sugar cane juice.

In France the sugar beet constitutes one of the most important commercial sources of alcohol, but in the U.S.A. alcohol is not made directly from beets. Beets of good quality should yield approximately 23 gal. of 99.5% pure alcohol per ton. Production of alcohol from beet sugar molasses is negligible ; it is used more largely for the production of yeast and fermentation citric acid.

Commercial use has also been made of 'citrus molasses' which is made by concentrating the waste waters (press

**Industrial Alcohol.* By P. Burke Jacobs. Pp. 99. Miscellaneous publication No. 695, U.S. Dept. of Agriculture, Washington, 1950.

juice) of the citrus canning industry. The sugar content of the molasses is about 42% and nearly half of this represents simple sugars (C_6 or hexose sugars). Approximately 4 gal. of 95% pure alcohol may result from 100 gal. of liquid press juice. Costs of production of this molasses are likely to remain relatively higher than for blackstrap and the supply may be limited. Other saccharine materials which have been used for industrial alcohol production are hydrol, a syrup by-product resulting from the manufacture of refined corn sugar, fresh or dried fruits, sorghum, whey and skim milk. The last two contain lactose, a fermentable sugar which is a dissacharide or 12-carbon sugar and therefore has a rather more complex chemical structure than glucose, dextrose, or fructose. A special type of yeast is employed for fermenting.

Starchy materials

The principal starchy materials that have been used commercially for making industrial alcohol are maize, grain sorghum, wheat, rye, barley and potatoes; rice is also used in oriental countries. As cereals and potatoes command relatively high prices as foodstuffs their use as raw materials for alcohol production is restricted except for beverage-alcohol manufacture. In general, alcohol yields are in direct relation to the starch or sugar content, and the relative value of any raw material in this respect can be computed with fair accuracy.

The most abundant cereal of the U.S.A., maize, has been used principally for beverage-alcohol rather than for industrial alcohol production and in the U.S.A. it is the main source of raw material for whisky distilling.

Grain sorghum is nearly comparable to maize as to alcohol yield, methods of handling and processing. Since 1944 its use has increased greatly and the material is generally very acceptable.

Barley is of interest chiefly from the standpoint of malt production. Malt is required for the conversion of starch in grain, unless acid saccharification or the use of moulds or bacterial enzymes is employed. Barley itself is seldom used as a direct source of industrial alcohol or for beverage-alcohol, except in beer and Scotch whisky. About 37.4 lb. of dry, de-sprouted malt are produced from 48 lb. of original barley.

Rye is used principally for whisky production in America and its use for industrial alcohol is unusual, although it is used to some extent for malt production.

The fermentation of wheat often presents particular difficulties because the protein (gluten) causes foaming of mashes and failure of by-product recovery equipment; mixtures of maize and wheat are, however, normally handled without trouble when the wheat constitutes less than half of the mixture. Soft wheats, with their lower protein and higher starch content, are more acceptable as distillery materials. The majority of wheat used for distillation is employed in industrial alcohol production, but a small amount is also used in beer manufacture.

Potatoes

Potatoes were formerly used extensively for alcohol production in Germany. Special types of potatoes with high starch content (18 to 20%) were developed and the technicalities of handling the material in small plants were extensively explored. In America the manufacture of alcohol from potatoes did not attain any commercial importance before World War 2, but in 1944 commercial trials of processing surplus potatoes into alcohol by first drying them in inactive sugar beet factories and then sending them to alcohol plants for conversion were conducted. The attempt was not economically successful and the quantities processed were small, about 7 tons of raw potatoes being required to produce 1 ton of dried flakes.

Other starchy materials which have been used or hold out possibilities for alcohol production are Jerusalem artichokes, cacti, manioc, arrowroot, sago and taro.

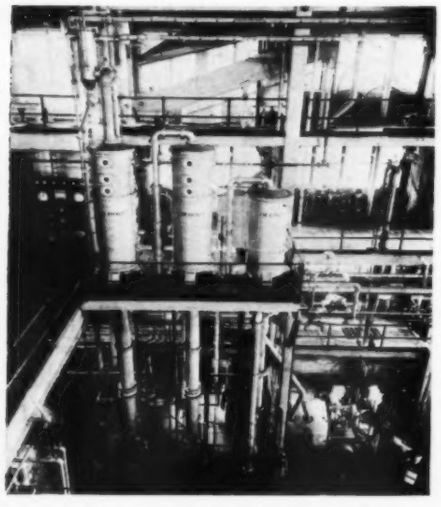
Cost of producing alcohol from crops

The cost of producing alcohol from crops depends on the location of the manufacturing plant, the design and type of the equipment, the type of raw material used and its cost, the cost of labour, the scale of production, the level of recovery and the amount of capital invested. Accordingly no definite or fixed cost of production can be stated.

An indication of the relative cost, using different types of material, can, however, be obtained from the table below.

Cellulose materials

In addition to the production of alcohol from crops containing sugar or starch, production from cellulose should also be



The feed recovery installation at Peoria where a mixture of dried solids (so-called light grains) and syrup, known as dark grains, is produced

ESTIMATED RELATIVE COSTS OF ALCOHOL FROM CERTAIN FARM CROPS IN COMPARISON WITH BLACKSTRAP MOLASSES (BASIS, 100 WINE GAL. OF 95% ALCOHOL PRODUCED, PRE-WAR PRICE BASIS)

Raw material	*Amount required (units)*	*Price per unit (delivered)*	*Raw material cost*	*Assumed processing cost**	*Total cost*	*Estimated credit for by-products†*	*Net cost of 100 gal. alcohol‡*
		$	$	$	$	$	$
Molasses (blackstrap)	250 gal.	0.05 per gal.§	12.50	6.00	18.50	0.50	18.00
Apples	7 tons	5.00 per ton	35.00	9.50	44.50	5.00	39.50
Corn	40 bush.	0.45 per bush.	18.00	16.00	34.00	7.00	27.00
Grain sorghum ..	45 bush.	0.40 per bush.	18.00	16.50	34.50	4.50	30.00
Potatoes	140 bush.	0.10 per bush.	14.00	13.00	27.00	2.00	25.00
Sweet potatoes ..	100 bush.	0.15 per bush.	15.00	12.00	27.00	1.50	28.50
Sugar beets ..	4.52 tons	5.00 per ton	22.60	9.00	31.60	3.60	28.00
Wheat (soft) ..	40 bush.	0.70 per bush.	28.00	18.00	46.00	6.10	39.90

*These costs represent the summation of a great many variables, and will differ for each plant. Malt costs are included for starch materials, but profit is omitted. Fermentation efficiency of about 85% of theoretical is assumed.

†Fuel oil and by-product feed (distillers' dried grains) only. The feed values will vary with changes in cost of the original raw materials.

‡These figures are the net resultant of many variables and must be considered as tentative. By-product feed values will be low at levels used. However, the figures shown probably reflect the relative order of alcohol cost for the raw materials and prices used.

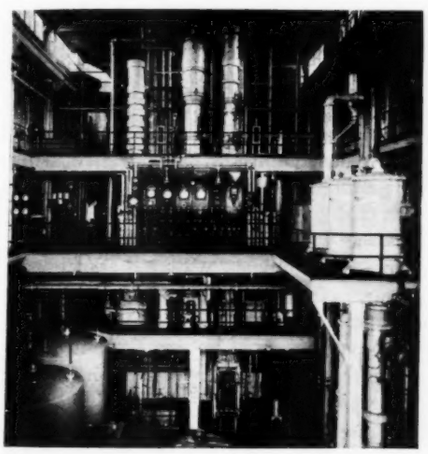
§Five cents a gallon is taken as a fair price for molasses, in comparison with the other potential alcohol sources. Prices of blackstrap molasses reached 37 cents. per gallon in June 1948, placing this material temporarily at a disadvantage with corn at co-existing market prices. Actually, at such prices the value of the sugar in the molasses was considerably higher than the prevailing price of raw sugar, illustrating how far the blackstrap situation had become abnormal.

mentioned. Alcohol can be produced from wood, from cellulosic agricultural residues and from waste liquor from the manufacture of wood pulp by the sulphite process.

Wood and wood wastes

The utilisation of wood for the production of ethyl alcohol entails two essential steps: (*a*) The hydrolysis of the cellulose of the wood to simple sugars, and (*b*) the fermentation of these sugars to alcohol by yeast in the usual manner. There are several general processes for carrying out the hydrolysis. The cellulose may be hydrolysed either with acids of low concentration at comparatively high temperatures or with concentrated acids at comparatively low temperatures.

The relative value of the conversion processes depends on the cost of the raw material and processing, and on the subsequent utilisation of the lignin and other



Distillation apparatus. Fermented mash is pumped to the top of the left hand column, free steam being blown upward through it as the liquid descends. Weak alcohol vapours issue from the top of this column and pass to the large (middle) column where aldehydes are removed through the top condenser. The refined, concentrated alcohol vapours are passed to a small column (hidden), are further rectified and then condensed

residues so as to obtain offsetting credits. Vast amounts of alcohol could be produced from wood wastes or from cellulose in general if an economic process could be perfected, while some of the other sugars (principally pentoses) formed in the hydrolysis, which are not decomposed into alcohol by yeast, could be utilised for the production of furfural or other chemicals, food yeast or stock-feed ingredients.

In ordinary lumbering operations only about one-third of the tree is recovered as finished lumber and large quantities of waste are produced. Economic utilisation of the latter for alcohol production would depend on concentrating these wastes at suitable points in amounts sufficient to permit economic plant operation, and on the type of process used.

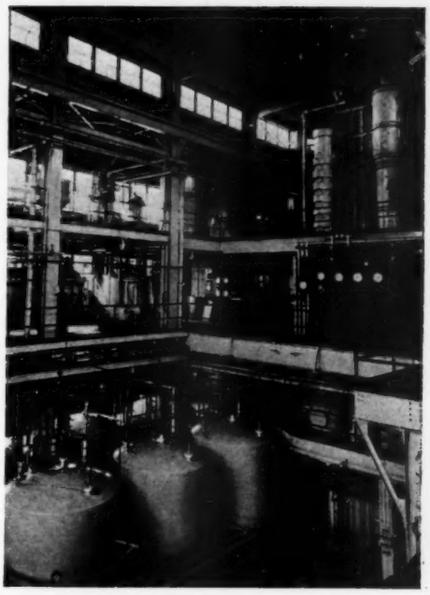
It has been estimated that a plant of economic size (*i.e.* one producing 12,000 gal. of alcohol per day) would have to utilise 220 to 250 tons of dry, mill-run wood waste per day to produce 4.1 million gal. of alcohol per year. In the light of this it seems that in the U.S.A. at present the number of operating mills of size sufficient to permit operations on this scale is somewhat limited, while the actual availability of waste—that is, the net amount available —may be a further limitation.

Agricultural residues

Cellulosic agricultural residues could also be used in lieu of wood in these processes, inasmuch as they consist essentially of cellulose, pentosans and lignin. However, although the total carbohydrate content of agricultural residues is about the same as that of wood (65 to 70%), they contain relatively less cellulose but considerably more pentosans, and the same amount of alcohol-yielding sugar (dextrose) cannot be produced from a ton of them as from a ton of wood. On the other hand, the relatively low cellulose and high pentosan content may not be entirely a liability, since a number of industrially valuable products can also be made from the pentosans; for example butyl alcohol, acetone, furfural, xylose, xylitol and fodder yeast. The production of such materials from the pentosans not only might help to defray the cost of alcohol production but also might make the sale of lignin a less important factor in the economics of the saccharification operation.

The Synthetic Liquid Fuels Project of the Bureau of Agricultural and Industrial Chemistry, in Peoria, Illinois, is investigating, on a semi-works scale, the cost of converting agricultural residues to xylose and dextrose and their ultimate conversion to products utilisable as motor fuels. The semi-works plant has a theoretical capacity of 3.3 tons of agricultural residues per 8-hour day, producing approximately 1 ton of glucose (at 10% concentration), 1,600 lb. of xylose (at 15% concentration), 200 lb. of furfural and a residue of 1,000 lb. of lignin.

For every lb. of grain grown, about 1 to 1½ lb. of straw, corncobs, corn stover or other residues are produced and, in consequence, very large quantities of them might be made available. At present it is largely unavailable because normally it is



Grain cooking and fermenting system; equipment for two stages of yeast preparation can be seen on the upper floor to the right of the cooker

scattered throughout the farming areas, and the cost of collection is an impeding factor to its utilisation. In some cases, however, certain farm residues are collected at central points in food or textile-processing operations, *e.g.* corncobs, rice hulls, sugar-cane bagasse, oat hulls, flax shives, peanut hulls, etc., most frequently for use as fuel, although in a few cases the concentrations are sufficiently large to enable important industrial operations to be carried on, *e.g.* the production of furfural from corn cobs and oat hulls and the manufacture of insulating boards from bagasse.

Sulphite liquor

An indirect method of obtaining alcohol from wood is by fermenting the waste liquors from the sulphite pulping process used in producing paper pulp. About 2,000 gal. of waste liquors result from production of 1 ton of pulp containing 2 to 4% of sugar of which about 65% is fermentable to alcohol by yeasts. Before such liquors can be fermented the sulphur dioxide as well as the acetic and formic acid present must be neutralised or removed. Special types of yeast are required and the addition of urea or other source of nitrogen may be necessary. Alcohol yields are about 1% of the volume of liquid fermented. Alcohol recovery from this source has been successful in Germany and Sweden, while commercial plants have also been in successful operation at Thorold in Ontario in Canada, and at Bellingham, Washington, in the U.S.A. If the process proves economic

under future conditions a large potential source of relatively low-cost alcohol may be available.

Alcohol also is formed and recovered in some chemical operations such as methanol synthesis and ethyl cellulose manufacture. An hitherto untapped source may lie in high-pressure synthesis from carbon dioxide, although there has been little inducement so far to make ethanol by this latter process, yet the possibility exists and, in any event, the synthetic production of ethanol has made a tremendous advance in the U.S.A. of late years.

The changing trend in the sources from which alcohol is produced in the U.S.A. during the last 16 years is shown in the table given below.

Fermentation procedure

Most fermentation-type alcohol plants follow a generally similar process, although in each there are differences in the raw material used, type of equipment, the yeast strain, the processing temperature ranges and other factors, the concentrations employed and the recovery of by-products. Fermentation is conducted in large tanks or vats that are now usually constructed of of steel, although wooden-stave tanks formerly were used.

In fermenting molasses, the raw material is diluted to a concentration of 16 to 20% sugar and active yeast is added after the acidity of the solution is adjusted to the optimum (about 5.0 *p*H) for best fermentation. Fermentation is usually complete in 48 to 55 hours, depending upon temperatures, concentrations and other factors, after which the fermented liquor is passed to de-alcoholising and refining stills. Fruit and other sugar-containing materials would be handled similarly with macerating and steam sterilising steps preceding the fermentation.

When grain of material containing starch is used, handling, cleaning, weighing, milling and cooking precede the actual fermentation. After the cooking, which historically is a batch process, usually accomplished in horizontal steel pressure cookers, the ' mash ' must be converted, *i.e.* the cooked starch must be changed to sugar. This change is usually effected by malt, which contains the necessary enzymes.

After cooking, malting and cooling the mash usually is at a concentration of 30 to 45 gal. per bushel of grain and at a temperature of 78°F. as received in the fermenters. The fermentation procedure is substantially the same as that for molasses, until after distillation.

Processing of potatoes or other starchy root materials represents an operation intermediate between those for grain and for molasses. Simple maceration may replace grain milling; dryhouse equipment requirements are less than for grain, and steam requirements also are reduced.

The fermentation step for wood sugars is analogous to that for molasses, except that neutralisation of the raw solutions is necessary. The equipment for the hydrolysis of wood represents a greater percentage of the total capital investment.

TRENDS IN INDUSTRIAL ALCOHOL PRODUCTION, BY FISCAL YEARS, FROM VARIOUS RAW MATERIAL SOURCES*

Source	1934	1935	1936	1937	1938	1939	1940	1941
	%	%	%	%	%	%	%	%
Molasses	83.4	85.5	76.2	75.7	73.1	67.6	68.56	70.41
Grain	6.3	2.7	7.0	8.4	9.1	7.7	5.73	5.87
Synthetic	7.3	9.7	16.0	15.2	17.6	23.9	25.12	23.39
Other	3.0	2.1	.8	.7	.2	.8	.59	.33
Unfinished spirits	—	—	—	—	—	—	—	—
Potatoes§	—	—	—	—	—	—	—	—
Sulphite liquor	—	—	—	—	—	—	—	—

Source	1942†	1943†	1944†	1945†	1946†	1947†	1948
	%	%	%	%	%	%	%
Molasses	68.13	35.55	32.60	27.83	24.64	18.12	38.75
Grain	9.08	24.09	32.40	41.22	26.69	13.30	9.44
Synthetic	21.33	21.60	17.87	16.34	36.07	44.60	38.18
Other	.26	.57	‡10.02	‡9.54	1.03	1.64	2.50
Unfinished spirits	1.20	18.19	7.11	4.82	6.70	16.58	9.40
Potatoes§	—	—	—	—	1.07	4.30	1.32
Sulphite liquor	—	—	—	.25	.80	1.46	1.41

*The general production trend is not accurately reflected by the percentages shown for 1942-45, being disguised by (*a*) current shortages of molasses, (*b*) increased use of grain as raw material, (*c*) conversion of the entire beverage alcohol industry temporarily to industrial alcohol production for war purposes, and (*d*) large increases of total production occasioned by the war, which exceed the relative increases in synthetic-alcohol production.

†Based on production in industrial alcohol plants only, but including unfinished spirits originally produced in distilleries (largely from grain) and transferred to industrial alcohol plants for refining.

‡Mainly from grain mixtures.

§These percentages actually should be slightly higher (0.1 to 0.2) because of potatoes used in mixtures, shown herein as other.

The production of yeast is accomplished in stages; usually the start is from a small culture, and the succeeding steps, each producing a larger quantity, are timed to coincide with the operation cycle of the fermenters. The yeast is grown on a mash comparable with the general type of material fermented in the alcohol plant, and is maintained at an acidity of approximately 4.5 *p*H to retard the growth of deleterious bacteria.

Grain plants are usually confronted with the necessity of storing raw material sufficient for operations for extended periods. Moisture in the grain, if excessive (over 15.5%), may bring problems of grain heating or damage by micro-organisms. Milling becomes difficult at a moisture content exceeding 17.5%. Drying of grain by heat may affect the fermentability if too high temperatures are employed. A range of 130 to 170°F. may be allowable, but must not be exceeded. However, mould- or heat-damaged grain apparently can be fermented without much loss of alcohol yield.

Alcohol as a fuel

The possibility of using alcohol as a fuel in internal combustion engines, particularly in motor cars and tractors, has for long attracted attention. Prior to and during the war in countries producing molasses some developments occurred, notably in Mauritius and South Africa and also to some extent in Germany. The difficulties in importing petrol to some countries far distance from sources of petrol gave an impetus to this.

However, alcohol has a much lower heat-producing capacity than has petrol; thus a gallon of ordinary petrol represents from 110,000 to 130,000 B.Th.U., while a gallon of alcohol might yield 78,000 B.Th.U. The position may be slightly more favourable than this, since other factors enter into the question, but at best under present conditions alcohol is more expensive, and as a straight fuel under normal conditions it can hardly compete. Blending alcohol with petrol may offer better prospects, while the use of it as an extra fuel injected during periods of heavy load to improve the functioning of the engine is also not unpromising.

Proposals for the extensive use of alcohol as a motor fuel stem from three main considerations:

(*a*) Possible future shortage of petroleum as a result of the depletion of irreplaceable sources.

(*b*) Possible occurrence of surpluses in farm crops.

(*Concluded on next page*)

Aerial Dusting from Fixed Wing Aircraft

With wheels barely off the ground the DH Tiger Moth speedily covers the ground with dust

THE use of aircraft for dusting and spraying has attracted much attention of late years. Machines of both the fixed wing and autogyro type are used. Both have their advantages; fixed wing aircraft have attained a not inconsiderable popularity in the U.S.A. and have also been used in Natal for the prevention of tsetse fly, but they have not obtained large application elsewhere.

Consequently, interest was attracted by an aerial fertiliser application demonstration recently given by an aircraft of Messrs. Spray and Win. In this a special modified Tiger Moth aeroplane was flown from an operational height of 8 ft., dusting and spraying a strip of ground about 30 ft. wide.

The display was believed to be the first of its kind to be held in Great Britain. The equipment which had been previously used on a variety of aircraft in the U.S.A. had been adapted for use in a Tiger Moth plane and consists essentially of a hopper mechanism built into the forward cockpit; from this the dust was fed to a 48-in. " sprayer " mounted just forward of, and below the trailing edge of, the lower wing. Clogging of the dust is eliminated by an agitator driven through reduction gearing from a windmill mounted on the starboard lower wing; an air scoop incorporated in the mechanism promotes suction, on the venturi principle, which feeds the dust to the sprayer. The hopper capacity is up to 500 lb., depending on the fullness of the fuel tank. During the demonstration, dust was applied to the field at the rate of about 30 lb./acre and fertiliser at 2 cwt./acre.

A new dust has been developed by Plant Protection Ltd. after eighteen months' research to find a non-dollar substance suitable for mixing with fungicides and insecticides for this type of work. Dozens of products, including industrial, mining and quarry by-products, were examined by means of a new machine developed at the laboratories to find this dust " filler." It is very fine, flows freely, carries gamma benzine hexachloride and other insecticides and fungicides efficiently, and it retains these properties under severe changes of temperature and humidity and in storage. It does not float in the air but sinks quickly onto its target. This ' filler ' is being incorporated with BHC, DDT and sulphur and used in Egypt against one of the chief pests of cotton, the cotton leaf worm.

It is anticipated that trials will be arranged to demonstrate the applicability of the method to crops under overseas conditions.

Alcohol and Agriculture—*concluded from previous page*

(*c*) Use in foreign countries which are deficient in petroleum resources.

It would seem that alcohol production for fuel purposes would have to come from agricultural sources and involve fermentation. Such a programme would probably have to be based mainly on the cereal crops; others might find some utilisation in time, while certain culls and wastes of raw crop material might be used also to a limited and uncertain extent. At present rates of crop production only a portion of the vast quantity of alcohol that would be needed could be provided.

Production difficulties

Moreover, the production of alcohol for motor fuel from a variety of farm crops and wastes would entail the problem of equilisation of wastes, since this would vary for every raw material. Any industrial use of crops for alcohol production, therefore, would have to be based on continued ample sources of raw materials at suitable price levels.

The present commercial output of alcohol from suitable sources such as molasses and grain or by synthesis sets a competitive price standard, while crop culls and wastes usually consist of poor materials and are unsaleable under usual market conditions. While, therefore, large-scale production of alcohol as an alternative source of motor fuel cannot be entirely disregarded, the future must depend on the relative costs of petroleum and alcohol production. Moreover, it is not beyond the bounds of possibility that the whole situation in regard to power supply might, within a measurable space of time, be completely changed owing to developments in the use of atomic energy.

(Photos: U.S. Dept. of Agric. taken at the alcohol production pilot plant at the North Regional Research Laboratory, Peoria, Illinois)

Dutch Fodder Bureau

One of the foremost requirements of Dutch agriculture is cattle fodder, and as a result of the necessity for saving hard currency and intensifying agricultural production farmers are being pressed to produce as much of their own cattle fodder as possible. Actually, in 1949 more than 175 million guilders in hard currency were saved on imports of cattle fodder.

If all goes well the 1950 sugar beet crop should yield not only 350,000 tons of beet sugar but also 100,000 tons of molasses, 1.5 million tons of beet pulp and 1½ million tons of beet tops.

To ensure that economically sound use is made of this material the Dutch beet sugar industry, in co-operation with the Department of Agriculture, have recently established a Fodder Research Bureau in Amsterdam with the object of developing efficient and economical methods of using molasses and beet pulp as fodder.

Elephant Grass

An Important Tropical Forage Crop

R. O. WHYTE, Ph.D., B.Sc.

Of recent years elephant grass or Napier fodder has gained steadily increasing popularity as a tropical fodder crop; it is also valuable in a variety of other ways, notably as a soil ameliorative, to provide protection against erosion, and it can be used for thatching and for making paper pulp; it is extensively grown in many countries. In this paper the author, who is well known as an authority on matters relating to fodder crops and pasture management, discusses some of the problems relating to its cultivation and harvesting.

ELEPHANT grass, Napier grass or Napier fodder (*Pennisetum purpureum*), is one of the most important sources of animal fodder in the tropics and subtropics. In addition to providing food for livestock, it is also of value as fuel for cooking, it can be used in various ways for house construction, and the stems make paper of better quality than esparto grass, producing a satisfactory yield of good pulp.

Pennisetum purpureum is a native of the tropical tall-grass savannas of Central Africa, and it is here that it has acquired possibly its highest economic importance, in restoring fertility to land which has been cropped, and in being largely responsible for the building-up of soil fertility over large areas of Uganda, for example. It is because old abandoned farms are colonised by elephant grass within two to three years that so much of Uganda has been able to support so large a population for so long. It was on elephant grass that W. S. Martin carried out his work which has led to a greater appreciation of the value of the grass roots in influencing soil structure under tropical African conditions.

Description and characteristics

This grass is a leafy, branching, perennial of vigorous growth, forming large bamboo-like clumps 12 to 15 ft. high. Dense stands cover much of those parts of Uganda at 3 to 5,000 ft. altitude which have a well-distributed rainfall of 45 in. or more. It has been introduced to many other parts of the tropics and subtropics. It is an important source of fodder in the West Indies and the Pacific Islands. It has also been introduced successfully into the Philippines, India, Ceylon and the East Indies, and into Florida in the United States of America.

Elephant or Napier grass has a strong, extensive fibrous root system which enables the plant to become quickly and permanently established in the soil. The leaf blades are usually 1 to 1½ in. wide and 2 to 3 ft. long. Tillering is profuse and as many as 50 to 100 stalks are produced from a single plant. When the plants are approaching maturity, numerous fine branches appear, growing out from the leaf axils of the main stems. These branches as well as the main stems bear terminal condensed panicles or seed heads which are golden yellow to tawny in colour and from 5 to 10 in. in length.

The varietal position in the species *Pennisetum purpureum* is a little obscure. Different workers in various parts of the world refer to elephant grass, Napier grass or fodder, Merker grass, the 'Umfufu' variety, and so on. These all appear to be somewhat indefinite types within the species. A reference has been seen to a variety 'B' growing in trial plots in the State of Mato Grosso in Brazil. The only serious selection work which appears to have been attempted has been the production by the Agronomy Division of the Hawaii Agricultural Experiment Station of strains resistant to eyespot (*Helminthosporium ocellum*), and the study of more prolific strains in the Union of South Africa, to which Dr. I. B. Pole Evans referred in a recent article.

Propagation

W. J. Eggeling of the Forest Department, Uganda, has given an account of experiences and practices with this grass in that territory. There they find that it resists drought and annual fires; although readily eaten and palatable to livestock, it does not stand heavy grazing; if the succulent young shoots are repeatedly grazed, the grass soon dies out. As a green fodder plant it does, however, hold a foremost place among the grasses of East Africa. Except in the higher altitudes, it can be established in most areas of medium rainfall, growing quickly and cutting well. Its cultivation may even be extended into typical short-grass country if protected from fire and regularly cleaned to reduce competition from such species as *Cynodon dactylon* and *Digitaria scalarum*. A suggested procedure is to weed the crop until it is about 4½ ft. high, cut it back to 1 ft., weed again until it is 5 ft. high and replant blanks. With reasonable rains a good stand may be obtained in 18 months.

Most workers refer to the establishment of elephant grass from root and stem cuttings; although the plants may seed freely, the seeds drop early and are difficult to collect. When the plants are young they may be used to make good quality hay, but their succulence makes them more suitable for soiling and ensilage. It is considered desirable that a stand should be cut before it has made 3 ft. of growth, to reduce the percentage of woody stems.

Yields

Under favourable conditions in Uganda, a yield of over 50 tons per acre (green weight) can be obtained, and even in a drought year at one centre, a manured plot yielded at the rate of over 26 tons per acre. Figures quoted for Hawaii are 87.75 tons from five cuts (12.3% air-dry forage), and in another experiment 80.55 tons from five cuts (10.8% air-dry forage). The average figure for Hawaii would appear to be in the region of 70 tons green per acre per annum at 21% average dry matter content.

Feeding value

The Hawaii Agricultural Experiment Station has made an interesting comparison of roughages used in the important dairy industry in the island, in which milk production has more than doubled and consumption per head trebled in the period 1923/43; 79% of the total milk supply in 1940 was produced on the

Island of Oahu. On the outside islands and on windward Oahu, the dairies grow the roughages in pastures. Near Honolulu they grow them as soiling crops or obtain them in the wild state from waste areas. Two important concentrates, pineapple bran and cane molasses, are produced locally as by-products, but other concentrates have to be imported.

Napier grass ranks first among the roughages tested in these trials, on both a green and a dry-matter basis. Palatability varies with the age of the grass, and unless this is first run through an ensilage cutter, cattle will not eat the coarse stem. Guinea grass (*Panicum maximum*) and Napier grass were approximately equal in palatability and milk production.

An interesting point arises in the comparison made between Napier grass and a legume, *Desmanthus*. The tropics are very short of good legumes to take the place of the clovers and lucernes of temperate lands. Although Napier grass was 28% more palatable than the *Desmanthus*, the latter supplied twice as much protein through being higher in both dry matter and protein. The milk production was 3.7% greater when the legume was fed, and this difference is statistically significant. Grasses tend to surpass legumes in total digestible nutrients produced on a given area of land. For this reason, the authorities in Hawaii advise the dairy farmers to grow the high-yielding grasses, and to purchase the protein supplements, if land is scarce and costly. They may be wise to grow some legumes if land is available and cheap. Rarely are mixtures of grasses and legumes grown on the same lines as in an English 'pasture,' when the grasses are the giants of the Napier type.

Cutting rotations

The late Professor D. D. Paterson, of the Imperial College of Tropical Agriculture in Trinidad, carried out one of his chemical and nutritional studies on elephant grass, testing the effect of stage of cutting on the yield and composition. Three times of cutting were chosen, namely, series A—cut every 4 weeks, series B—cut every 8 weeks, and series C—cut every 12 weeks. The trials therefore represent a tropical variation of Dr. H. E. Woodman's investigations on similar lines in Cambridge. The duration of the experiment was 12 months.

Within the 12-week cutting rotation, it was found that the longer the interval between crops, the higher the yield per acre both of green herbage and of dry matter. The relative yielding potentialities of the three treatments, expressed as a

Typical stand of elephant grass; note the many stalks on one plant as a result of tillering

Self-propelled forage harvester embodying harvester unit, storage bin and propulsion unit in one machine

percentage of yield of series C, were :—

Series	Herbage	Dry Matter
	%	%
A	56.5	39.2
B	83.7	65.4
C	100 0	100.0

The average height of the tillers when cut was 1½ to 2 ft.

Professor Paterson found that cropping as frequently as every 4 weeks affects the vitality of the grass, produces a smaller root system and a less virile stool, and ultimately leads to a high mortality in the individual stools. In nutritive value, the average grade of green fodder is roughly equivalent to medium-quality English meadow hay. The grass is rather lower than the hay in crude protein. When compared with English herbage cut on a monthly cropping rotation, even the least mature cuts from series A give a very low protein percentage.

Effect of climate on composition

A definite correlation exists in an insular tropical climate between the monthly precipitation and the composition of the herbage. In these Trinidad cutting trials, dry matter, crude protein and ash percentage all vary inversely with the rainfall. There is a fall in percentage in the wet months, whereas the crude fibre percentage tends to increase. As the productivity of elephant grass is at its highest in the heavy rainfall months when the soil is copiously supplied with moisture, this seasonal fluctuation in the composition of the grass means, as Professor Paterson points out, that when the crop is growing more vigorously the nutritive value per unit weight of herbage is at its lowest

The 3-month cutting rotation adopted in the Trinidad trials therefore has distinct advantages over the more frequent cutting systems. In addition to giving the much higher yield of green fodder and of crude protein per acre, it was found that the decrease in nutritive value when compared with younger herbage is not excessive, and the rise in crude fibre not so great as to lower unduly the digestibility when fed to tropical stock. This cutting regime also favours healthiness and longevity in the plant ; in producing a type of stool with a much larger root system, it induces greater productivity and renders the crop less susceptible to weed competition.

Harvesting problems

The economic harvesting of green material of the type of elephant grass obviously presents considerable problems. Harvesting by the grazing animal *in situ* may be practised to some extent, but this cannot be regarded as a permanent and desirable method under most conditions. Where labour is still cheap, harvesting of the green material by hand may be practicable for some years to come, but the trend already evident in a territory such as Hawaii may be expected to appear progressively in other parts of the world.

One of the problems of the Hawaii dairy industry is the high cost of feed, and a controlling factor is the cost of hand labour to harvest the green crops. Any reduction in forage production costs might well be reflected in a drop in the price of fresh milk, and in lower sales of canned and reconstituted milk.

In Hawaii, green forage is cut, chopped, and fed fresh daily. There is no need for

Trail-type forage harvester suitable for work on level land and large fields

conservation as green crops are available throughout the year. With the increasing use of lucerne and other crops, it seems probable that present harvesting practices may well become modified along lines already characteristic of the mainland, particularly as regards the use of the forage harvester. The corn binder is employed successfully in the harvesting of *Leucaena glauca*, a valuable legume in the Islands, but this does not operate successfully with Napier grass. It is thought probable by the authorities in Hawaii that the substitution of appropriate machinery for hand labour will substantially reduce the man-hours per ton of forage harvested. Whereas mowing Napier grass with a 3- to 5-ft. tractor mower followed by chopping requires four man-hours per ton with an efficient crew, mechanical harvesting with field forage harvester choppers should reduce the mowing and chopping operation to 0.3 man-hour per ton. A report of a special investigation on ' Mechanised harvesting of Napier grass and other Hawaiian forage crops,' by John F. Cykler, has been published as Bulletin 102 of the University of Hawaii Agricultural Experiment Station, February 1950. The problem to be faced by Mr. Cykler was to develop existing types of field forage harvesting equipment to meet the high yields of the widely-stooled crops, to operate over ditches, and to operate with relatively short rows and lack of headlands.

Napier grass in Hawaii is not usually planted on the best lands ; many fields planted to Napier grass are not flat and of even terrain ; with continuous cropping and irrigation, the fields become very ridged and rough. Most fields are ploughed and replanted every 10 years. These conditions combined with the lack of headlands make it difficult to use wheeled harvesting equipment without damaging it.

Harvesting equipment

Although the trail-type forage harvester equipment would be quite suitable for relatively smooth lands and large fields, such as characterise the areas in the Platte Valley of Nebraska where they are used so extensively in the lucerne dehydration industry, they are not adapted for use on cultivated land which has become rough from the use of furrows for irrigation, or in fields which are small and irregular in shape. Representatives of the dairy industry in Hawaii presented objections to the use of trail-type equipment. They noted that trail equipment means a tractor, a forage harvester and a wagon, and considered that such equipment could not operate efficiently on the small rough fields.

They preferred a self-propelled forage harvester which would embody in a single machine the harvester unit, storage bin, and propulsion unit. Mr. Cykler and his associates assembled a machine of this type, using as basic units a 40-drawbar horse-power International T-9 wide-tread crawler tractor, the modified No. 2 McCormick-Deering field forage chopper, and a 20 horse-power JE-4 Wisconsin engine for an auxiliary power unit (a 25 h.p. VF-4 would be preferred). A steel bin, $3\frac{1}{2}$ x 6 x 7 ft., was fabricated and mounted overhead on two pin pivots, as shown in the photograph.

Economic considerations

As the economics of such increased mechanisation of agriculture are always of primary importance, two tables (Tables 1 and 2) are quoted from Mr. Cykler's report. These show that, provided the tons per year and the size of the dairy in cows are adequate, the comparative cost of harvesting with the self-propelled forage harvester is not excessive, and the investment per cow within reason, even with the very high total investment of $11,500 for the ' home-made ' self-propelled forage harvester.

With the trend towards increased mechanisation of under-developed lands likely to continue, other workers will be faced with similar problems, varying as between one type of tropical condition or crop and another.

TABLE 1
COST COMPARISON OF VARIOUS HARVESTING METHODS, DOLLARS PER TON

Tons per Year	Present Methods	Trail-Type Harvesting	Hawaii Self-Propelled Forage Harvester
6,000	3.39	1.06	1.27
4,800	3.40	1.06	1.28
3,600	3.41	1.07	1.30
2,400	3.45	1.09	1.31
1,200	3.63	1.20	1.71
600	4.09	1.41	2.50

TABLE 2
HARVESTING AND CHOPPING MACHINERY INVESTMENT, DOLLARS PER COW

Size Dairy in Cows	Present Methods		Trail Harvester Chopper		Hawaii Self-Propelled Forage Harvester	
	Total Investment	Investment Per Cow	Total Investment	Investment Per Cow	Total Investment	Investment Per Cow
500	5,115	10.2	4,575	9.2	11,500	23.0
400	5,115	12.8	4,575	11.4	11,500	28.8
300	5,115	17.0	4,575	15.2	11,500	38.4
200	5,115	25.6	4,575	22.9	11,500	57.5
100	5,115	51.2	4,575	45.8	11,500	115.0
50	5,115	102.3	4,575	91.5	11,500	230.0

NEW BOOKS

Advances in Agronomy

Edited by A. G. Norman. Pp. xii and 439. Academic Press, New York, 1949, $8.

'Advances in Agronomy,' published under the auspices of the American Society of Agronomy, is a newcomer to the ranks of review journals which have been started since the war. This is itself a recognition of the autonomy of the study of crop-environment relations and a recognition of the existence of a body of scientific workers bound in interests by the application of their studies. It is interesting to find side by side in this first volume, articles on the production of soybeans and potatoes, the fixation of soil phosphorus, clay minerals in soil, the improvement of alfalfa, associations between soil micro-organisms and plant roots, and weed control. In fact the very diversity of the subjects raises the problem of what should or should not be included.

Like many border-line sciences, agronomy has no well defined boundaries, and is in danger of becoming a straggling assemblage of but vaguely linked subjects rather than a whole with independent parts. For this reason many of the reviews in this volume could fit comfortably into other existing review periodicals. Some indeed, *e.g.* the review by F. E. Clark, cover almost exactly the same ground as others in well known review journals published in the last year. This type of replication seems a pity since the articles 'are written primarily for fellow agronomists' who presumably have access to scientific libraries.

It seems desirable that this review should not seek to cover all the major advances which might come under the wide umbrella of agronomy, for many of the stimuli still arise from the various pure sciences. Thus it would be unfortunate if workers in applied science relied on reviews of applications and did not maintain links with the progress of pure science relevant to their interests.

The editor defines his editorial theme as crop soil relationships, but to the reviewer a better definition would perhaps be crop environment relations because if agronomy does have a discipline it is the integrated effects of environment including the soil environment on the growth and development of crop plants. If this definition is accepted then it is at once apparent that it is for certain reviews which cannot find a place in any other work, *e.g.* the chapters on the soybean, potato production and fertiliser practices, that this volume is most valuable.

The editor also states that this first volume is primarily concerned with North American agronomy, but it is intended that in later volumes authors from other continents should be invited to contribute articles. Since agronomy has such a diversity of interests it calls for a diversity of approach within even relatively narrow fields because the local climate must determine to some degree the agronomist's interests and type of research.

Of the individual reviews W. G. Weiss' 'Soybeans' is a model review for an agronomical journal. C. Smith's 'Potato Production' is comparable in scope to the soybean review. W. J. White's 'Alfalfa Improvement,' F. E. Clark's 'Soil Micro-organisms and Plant Roots' and A. S. Crafts' and W. A. Harvey's 'Weed Control,' all cover material which has recently been adequately reviewed elsewhere. The review by Crafts and Harvey of 'Weed Control' emphasises the weight given to North American practice in this volume. MCPA the most widely used of the growth regulating substances as a herbicide in Britain and some Continental countries scarcely receives mention. Five of the reviews are concerned with soil and fertiliser problems. G. E. Hayward and C. H. Wadleigh consider the problem of 'Plant Growth of Saline and Alkali Soils,' which is a special regional problem of irrigated soils particularly in areas west of the Mississippi. R. J. Jones' and H. T. Rodgers' 'New Fertiliser Practices' falls into two parts. In the first the industrial processes of fertiliser production and particularly the manufacture of calcium and potassium metaphosphates and their use is discussed; in the second the methods of application of fertilisers is reviewed and particular emphasis given to the use of anhydrous ammonia as a cheap nitrogen fertiliser.

The 'Clay Minerals in Soils' by J. E. Gieseking is a review for the soil physicist rather than the agronomist, and 'The Fixation of Soil Phosphorus' by L. A. Dean is another example of a soil science paper which makes no attempt to relate its contents to agronomy.

The type of soil science paper which is valuable is exemplified by the review of 'Boron in Soils and Crops' by K. C. Berger.

J. L. HARPER

Mineral Nutrition

'Mineral Nutrition of Plants and Animals' by Dr. Frank A. Gilbert. Pp. xii and 131. Hutchinson's Scientific and Technical, London, 12s. 6d.

Dr. Gilbert has attempted to perform a valuable service in the field of nutrition by presenting (all too briefly) a wide review of the distribution and role of mineral elements in plant and animal nutrition and their dependence on soil conditions. A principal objective was to 'serve as a foundation for more intensive research in restricted fields.' Unfortunately in casting his net widely, he has perhaps at times not delved sufficiently deep.

The book comprises 22 short chapters of varied quality dealing with all the known macro and micro nutrients and others of undoubted biological interest. It is creditable that the space devoted to essential micro nutrients exceeds that allotted to the more familiar macro elements.

Chapter III contains a useful and balanced discussion on criteria of biological essentiality but omits reference to Arnon's (1939) criteria. Treatment of phosphorus, copper, cobalt and iodine is relatively adequate and well informed. Aluminium and fluorine are dealt with in a concise but efficient manner. Persistent pleas of the writer for greater attention by nutritionists to quality factors in food in relation to mineral status deserve every encouragement.

Potassium and manganese would seem to the reviewer to merit fuller consideration. The section on calcium as it affects plant nutrition is somewhat vague and sketchy and proper discussion of soil acidity problems would have been welcome here.

The attention given to animal nutrition covers a wide field and examples of disorders are well chosen from many parts of the world. Problems of plant nutrition have been exemplified on a more limited scale based mainly on work in the United States, except for historical aspects.

A few misprints and doubtful statements occur. The date for Sommer and Lipman's work on boron (p. 80) should be 1926, and credit for the priority is surely due to Warington in 1923. References to cystine (pp. 47, 51 and Index) presumably mean cysteine (or preferably both in proper context). The terms 'Brassacaceous' (p. 47) and 'Brassaceous' crops (Index) could have been better stated as *Brassica* crops. Iron is concerned in the formation rather than the function of chlorophyll (p. 50) and the statement (p. 15) that 'soils in general are more deficient in

sulphur than in phosphorus ' will occasion surprise to soil chemists. The suggestion that molybdenum deficiency is unlikely to occur in the field has been discounted for some years.

The bibliography is one of the most useful features of the book. There are 329 references and these provide a wide and fairly representative selection of papers, somewhat biased to United States work. Omission of the important review of mineral elements in pasture as related to animal nutrition by Miss F. C. Russell in 1944 is, however, regrettable.

The 31 illustrations vary in quality and value. Glazed paper would have materially improved reproduction. Those showing animal disorders are mainly good and expressive. Examples of deficiencies of potash in lucerne, copper in *citrus* and zinc in peach are good but pictures of phosphorus deficiency in tomato (pp. 22, 24) and manganese deficiency in geranium (p. 62) convey little.

The book is reasonably priced and may be recommended for the attention of all professing to a general interest in nutrition and to agricultural, medical and veterinary students in particular. The specialist may yet require to possess himself in patience.

E. J. HEWITT

Aslib

Guides to Sources of Information in Great Britain. No. 2, ' Agriculture and Allied Interests.' No. 3, ' Beverages and Food.' Pp. 55 and 44. Aslib, London, 1949, 16s. and 21s. 6d. respectively.

These two publications produced by Aslib (Association of Special Libraries and Information Bureaux) give information concerning the various sources from which information can be obtained in the United Kingdom in regard to these two subjects.

They are each divided into three sections. The first dealing with relevant libraries and loan services and with the D.S.I.R., the second giving details of the organisations in Great Britain which are the main sources of agricultural and related information, while the third lists publications devoted to different aspects of the subjects in question.

In addition each volume contains a subject index of the organisations and of the publications listed.

Aslib was founded in 1924 and incorporated in 1926 as a non-profit-making institution. In 1948 it was incorporated with the British Society for International Bibliography and adopted its present title. Membership is open to all concerned with documentation, information work and special librarianship at home and overseas.

Land, Rainfall and Population Maps—Explanatory Texts

The first three explanatory texts to accompany maps in the 10 miles to 1 in. (1/625,000) series of planning maps produced by the Ordnance Survey Office, of the United Kingdom, have now been published. These texts have been prepared by the Ministry of Town and Country Planning and the Department of Health for Scotland. Great Britain is covered by two sheets, sheet one including Scotland and Northern England, and sheet two the remainder of England and Wales.

Land classifications, average rainfall and population are the subjects of these first texts, which help to make the maps fully intelligible to the layman.

One text shows how the agricultural land of the country has been divided into ten categories, ranging from first-class land, such as is largely used for intensive market gardening, to the poorest land—for example, saltings and rough marsh. The areas and percentages of each category of land in every country are given in the text.

Lincolnshire is the county with the highest acreage (530,900) of first-class land, followed by Cambridgeshire (274,300), Lancashire (237,000), Norfolk (193,000) and Kent (175,400).

Of the Scottish counties Angus (77,200), Berwick (68,700), Fife (59,800) and East Lothian (49,800) have the highest acreages of first-class land.

The rainfall map is based on averages over a period of 35 years, but it also gives information on variability of rainfall. Among other things the explanatory text indicates the significance of this variability from one year to another as well as from place to place.

Population maps, which will number eight in all, and of which six have already been published, show population densities, total changes and changes by migration. The text, in explaining the complications of preparing maps of population movements, warns of care which must be exercised in drawing conclusions about internal migration.

Other maps already published, for which, where necessary, explanatory texts will be issued later, show for instance, electricity supply areas, land utilisation, roads, coal and iron, types of farming, and administrative areas.

The maps and explanatory texts can be obtained through Ordnance Survey Agents and many booksellers. The maps in most cases cost 5s. per sheet and the explanatory texts 9d.

Improved Rice Varieties Evolved

Several improved varieties of rice capable of increasing the yield between 16 and 32% have been evolved as a result of a paddy research scheme sponsored by the Indian Council of Agricultural Research in Travancore. The scheme has been functioning since 1940 at the Paddy Breeding Stations of Monkompu and Adoor in Travancore. According to the final report on the scheme just published, the following improved rice varieties have been evolved:

(*a*) *Variety MO*1. It is a high-yielding strain of a local rice variety called ' Chettivirippu ' and has given an average increase of 30% in yield test trials. This variety grows well in Salem area. The duration of the crop is 90 days and the average yield is 1,800 lb. per acre;

(*b*) *Variety MO*2. It is derived from the most popular local rice variety known as ' Kallada Samba.' It has given an increase of 22% in yield trials. With a crop duration of 95 days the average per acre yield comes to 2,000 lb.;

(*c*) *Variety Ptb.* 10. The average increase in its yield in three season tests was found about 20% and the yield per acre under local conditions was 1,800 lb.

Another interesting result of these experiments is the possibility of introducing a third crop of rice during the year in some areas of Travancore where irrigation facilities exist. It was found that *Ptb.* 10 grew successfully in these areas between January to March, provided water was available, thus increasing the crop yield by about 50% over present production.

Steps have been taken to multiply and distribute the improved strains to the cultivators. Nucleus stocks of pure seed were supplied to 'A Class ' seed growers for multiplication under Government auspices. The seed thus multiplied was supplied to ' B Class ' growers for large-scale introduction to the fields. A total quantity of 32,352 lb. of seed of *MO*1, *MO*2 and *Ptb.*10 has already been distributed to the ryots and a large stock is in hand for distribution during the next crop season.

Grain and Seed Cleaning Plant

R. A. COLBURN

Production of clean, well-graded seed is obviously advantageous to the grower, whether it is to be sold off or retained on the farm. In the following article types of machines used in seed cleaning are considered and layouts for single-purpose cleaning units and combined plants are illustrated.

SEED units capable of handling any types of cereal, grass and clover seeds are usually constructed to handle the following capacities:

Cereal Seeds	*Grass Seeds*	*Clover Seeds*
20 cwt./hour	2½ cwt./hour	5 cwt./hour
40 cwt./hour	5 cwt./hour	10 cwt./hour
60 cwt./hour	7½ cwt./hour	15 cwt./hour

For each unit of different capacity the types of machines used are exactly the same, but the individual sizes are increased.

In dealing with the cleaning of cereal, grass and clover seeds as a whole, it is advisable to consider the important points stage by stage, taking them as follows:

(1) Size of plant. Machinery needed to fulfil requirements.

(2) Planning with regard to site and buildings.

(3) Final details of plant and flow of seeds.

Size of plant and machinery

When thinking of the size of a seed cleaning plant it is usual to state the *total hourly capacity* required on the respective types of seed which the plant will have to handle. This total capacity may be given by one unit; on the other hand, it may be necessary, or even advisable, for several units to be installed in order to obtain the required total capacity.

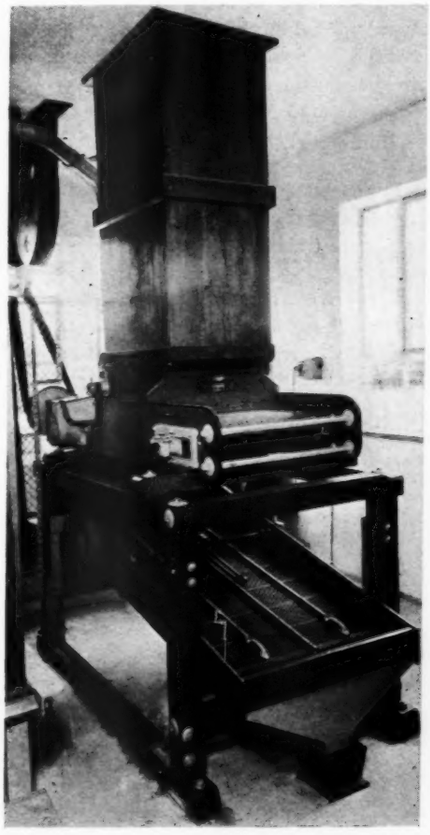
The 1 ton/hr. units are normally found in the smaller mills, and these operate very well where smaller quantities of seed are to be cleaned, at the same time maintaining a high annual output.

The 2 ton/hr. unit is very adaptable and capable of handling all types of seeds. Two, three or four of these separate units are to be found in the larger mills maintaining a high output and operating very efficiently.

The 3 ton/hr. units are found in some mills, but they need careful working if they are to be operated as economically as the smaller units.

Some of the larger firms have units capable of handling 4 and 5 tons per hour on cereals. These are of great value to the larger merchant, who can maintain a consistent output of 25 to 35 tons per day on the same seeds.

The 10 and 20 sack/hr. units are, as a general rule, the most widely used, and, when necessary, such units can also clean very useful quantities of grass and clover seed with very good results.



Band feeder and separating sieve

For cereal seed the various units consist of the following machines:

(*a*) *Seed Cleaning Separator.* A sieving machine fitted with fans for 'feed' and 'delivery' aspiration and mechanical sieve cleaning by means of brushes.

(*b*) *High-Speed Ultra-Meyer Indent Cylinders.* An indented cylinder machine with pressed steel indents fitted with internal spreader and exhausted at the delivery end. Wide range of indent sizes from 3½ to 10½ mm.

(*c*) *Powder Dressing Machine.* A dressing machine for the addition of mercurial fungicide powder to cereals, automatic cut-out for powder feeder when passage of grain ceases.

(*d*) *Cyclone Dust Collector.* This method of collecting dust is standard practice and these machines are much more efficient than the dust room.

Special purpose machines

The above machines are standard equipment for cereal cleaning and are essential if a high standard of work is to be done. There are, however, a number of additional machines which are of great benefit and undoubtedly go a long way towards making an even better job of cleaning the seed. These are:

(*e*) *Oat Clipper.* For firms in the seed oat trade this is an essential machine. It consists of revolving adjustable beaters in a woven steel wire cover. Husks and tails are aspirated to a dust collector.

(*f*) *Cyclo-Pneumatic Aspirator.* This machine is a completely self-contained closed circuit aspirator and does very useful work in cleaning or finishing off all types of seed, cereals, pulses, grasses and clovers. A very sensitive adjustment of this machine can be made.

(*g*) *Rotary Screen.* A rotary screen that can be used for grading seeds and making a very good job of pre-cleaning before grinding.

(*h*) *Spiral Separator.* A well-known machine similar to a 'helter-skelter' in construction and operation. Although capacity is very small, it is valuable in its ability to separate vetches from wheat.

(*i*) *Belt Gravity Separator.* This machine consists of an inclined travelling band and is widely used for cleaning sugar beet, mangold and other vegetable seeds.

The machines mentioned above are the ones which are to be found in cereal seed units. Some of them are used for the smaller seeds as well, and in many plants they are used to clean all types of seeds throughout the year.

Cleaning pulse and beans

Pulses, peas and beans require a rather different layout of machinery, as they do not normally pass through indent cylinders or powder-dressing machines.

Seed cleaning separators are used to remove split seeds and usual impurities with an adjustment to the construction of the delivery aspiration chambers. These machines can then be followed by two further machines. These are:

(*a*) *Cyclo-Pneumatic Aspirator*, which, as described, effects a very good aspiration and also *polishes* the seeds.

(*b*) *Table Separator or Dry Stoner*. This is a multi-compartment table separator and effectively removes all stones and dirt from the seeds.

Grass and clover units

For grass and clover seed cleaning, units will consist of the following:

(*a*) *Band Feeder with Hopper*. Consisting of a straight-sided hopper with a studded travelling band at the bottom, adjustable feed gate and agitator. Used for feeding grass and clover seed ex farm, which will not run down normal spouting or feed from grain type hoppers.

(*b*) *Roughing-out Sieve*. This is a single reciprocating sieve running at 520 r.p.m. Its duty is to pre-clean the delivery from the band feeder and extract rubble and stalk.

(*c*) *Seed Cleaning Separator*. With fine wire sieves for small seeds.

(*d*) *High - Speed Ultra - Meyer Indent Cylinder*. These cylinders are of the same design as the cereal cylinders, but with suitable indents for grass and clover seeds and running at reduced speeds. Grass cylinders have pressed steel covers, while clover cylinders are fitted with drilled zinc covers, almost any sizes up to 11 mm. being obtainable.

(*e*) *Reel Grader*. This is a small, accurately constructed wire reel placed before the clover cylinders to increase capacity and selectivity.

(*f*) *Rexman Screen*. This is a large capacity sieving machine with a rotary movement at the feed and reciprocating movement at the delivery end. One, two or three tiers of sieves can be proved. This machine is used for grass cleaning with woven wire sieves and has its own electric motor.

(*g*) *Cyclo-Pneumatic Aspirator*. This machine, as previously mentioned, is a self-contained aspirator and is of great value in effecting sensitive air separations as needed at various points in a grass seed plant. A spinning disc on to which the stock falls ensures an even stream of seed, which makes such sensitive work possible. The spinning disc has a light polishing action on clover, trefoil and lucerne, giving a very good ' finish ' to the seed.

Band and magnetic separators

Two additional machines must be mentioned as being unique in their separation and almost indispensable to any merchant in the clover seed trade.

(*h*) *Dossor Clover Selector*. This machine consists of a number of inclined velvet bands which are travelling at constant speeds. Broken seeds and weeds are picked up on the nap of the velvet and carried up over the top of the band, while normal clover seeds roll down the bands.

(*i*) *Purex Magnetic Separator*. An excellent machine for cleaning clover seeds and extracting such weed seeds as plantain (ribgrass) and dodder, which it is impossible to extract on any other type of separator. The seeds are mixed with a very fine dampened iron powder and then passed over a very powerful electro-magnet. The iron powder sticks to all rough-coated, irregular and broken seeds, and these are attracted by the electro-magnet, making a perfect separation possible. Capacities are 2½ cwt. and 12 cwt. per hour.

In concluding the list of machines used in grass and clover seed cleaning it must be mentioned that many other small seeds can be cleaned on these machines, such as vegetable seeds, canary seed and millet.

In the large ryegrass-growing areas, such as Northern Ireland, Ayrshire and New Zealand, special machines have to be used, such as ' jumping sieves ' and ' stepped type ' separators, for the removal of bromegrass and hairgrass from the perennial seed.

Planning with regard to site and buildings

The ease of working of any seed cleaning plant depends to a very great extent on the layout of the building and machinery. It will be agreed that where a three-story building is available, this makes for more economical working of a plant and, on an average, by far the greater number of merchants have such a building.

To illustrate the various ways of planning in seed plants, examples will be given of various installations erected by Thomas Robinson & Son, Ltd., which are all capable of economical working and will, perhaps, be useful for reference.

Cereal and pulse seed plant in three-story building. (Two units each of 20 sacks per hour capacity.)

Top Floor. Two large bins and elevator heads for feeding these with grain. Installed between top and first floors are the indent cylinders.

First Floor. Seed cleaning separators and the powder-dressing machines.

Ground Floor. Elevator boots and storage space.

This type of layout operates as follows:

Unclean seed is fed direct from stacks or road transport into the intake elevators on the ground floor, which feed into the large bins on the top floor. From these bins a gravity feed is obtained to the seed cleaning separators on the floor below. Seed is then elevated to pass through the indent cylinders, and from them a gravity feed is obtained to the powder dressing machines on the first floor.

Here the sacks are taken off the powder dressing machines by the operators, who stack on the same floor. They can keep a watchful eye on the whole unit, separators and cylinders, while looking after the weighing off, tying and stacking.

All tailings bags are taken off on the ground floor and looked after by the man feeding the intake elevators. In this way it is possible for four men to handle a *maximum* input of 4 tons of cereal seed per hour, from unclean to clean bagged, tied and weighed seed. On a man-power production basis this is good. It is essential to have an adequate bin space to give at the very *least* half an hour's running of the plant if labour is to be utilised in the most economical manner.

Grass and clover seed plant. (Capacity 2½ cwt. per hour grass seed. Five cwt. per hour clover.)

When dealing with grass and clover seed, it is necessary to use additional machines to those usually employed in a cereal or pulse seed plant. The following layout describes a model grass and clover plant which has the most up-to-date machinery installed. This is a three-story building again. Machinery is placed as follows:

Top Floor (small floor). Contains hoist and hopper to band feeder on the floor below. Cyclone dust collector, storage space.

First Floor. Band feeding and roughing out sieve, seed cleaning separator, grass seed cylinders, dosser clover selector, Purex magnetic separator. Shafting.

Ground Floor. Clover cylinders on high frame to allow for sacking off underneath. Elevator boots and all tailings spouts. Clean grass and clover seed.

When working this plant unclean seed, both grass and clover, is hoisted to the top floor and tipped into hopper to the band feeder. There is a limit to the amount of seed which can be emptied into this hopper, as all the seed rests on the travelling band. Roughly 5 cwt. of grass seed or 5 to 6 cwt. of clover are a maximum.

From the band feeder seed goes over the roughing out sieve and is then elevated to go over the separator; then grass seed is elevated a second time to pass over the grass cylinders, while clover seed passes

A battery of ultra indented cylinders and a seed cleaning machine

'Agrosan' powder dressers

The oat clipper installation

to the clover cylinders on the floor below. Clean seed is taken off on the ground floor. where it can be loaded to road transport.

This plant can be run with very little labour in an economical way and can be easily modified to clean cereal seed by the addition of a unit of grain cylinders and a powder dressing machine—providing space is available.

Before considering a combined plant, it is perhaps worth noting that where a firm needs a much larger total capacity than that of any self-contained units the usual practice is to install a number of medium-sized units as described.

The various machines are usually matched up to have all the separators on one floor, all the cylinders on the next, tailings bags and dressing machines on the floor below, and so on. The aim must be to 'group' the machines in such a way that the operators can work efficiently at their pre-selected job with a minimum of walking about to get at odd machines, bins or seed sacks. It *may* be possible to get nearly all the machines on one floor, and this does, of course, make it easier for the machine operator to look after his plant, although additional elevators are required.

Combined plants

When speaking of a combined plant it is usual to think of a large 'unit' which is self-contained and capable of cleaning all types of seeds. The unit described contains the necessary machines for cleaning such seeds and is rather more detailed than the average unit, as will be seen from the plan overleaf.

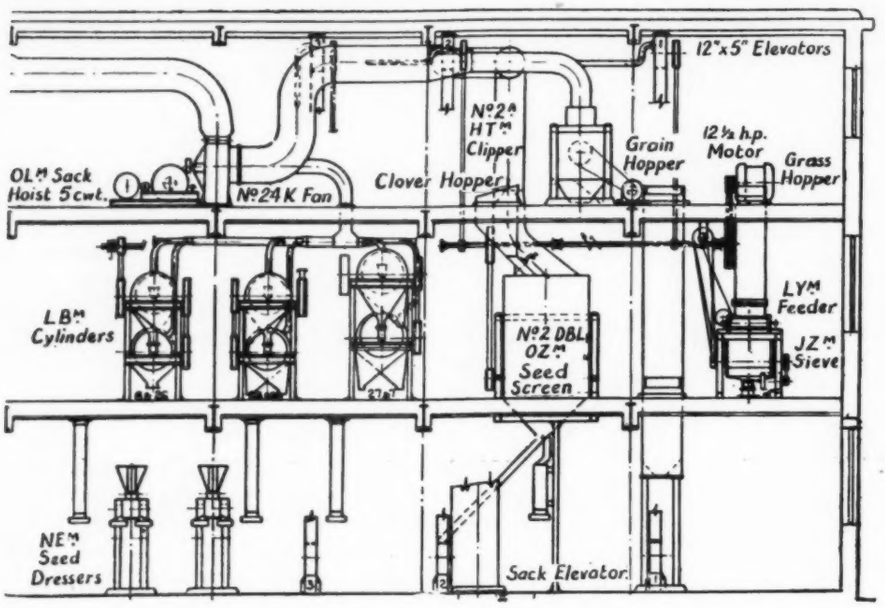
Such a plant as this requires more care in planning into a building, as full use must be made of all the machines. Here, again, a three-story building will be considered.

Top Floor. Oat clipping machine, elevator heads, top of sack elevator and bin extending to the ground floor. A small hopper to feed band feeder, a large central exhaust fan for all machines and a cyclone dust collector.

First Floor. Band feeder and roughing out sieve. Seed cleaning separator and cylinder units for cereal, clover and grass seeds. Line shafting and drives.

Ground Floor. Powder dressing machines, elevator boots and all main and tailings spouts.

In operation unclean seed is stored on the first and top floors where possible. Cereal seed is fed into the large bin where it is elevated to pass through the oat clipper on the top floor and thence by gravity to the seed cleaning separator below. From here it is elevated again and passes into the cereal cylinders on the



Layout of a three-storey combined plant, capable of cleaning all types of seeds

first floor. A gravity delivery is obtained to the powder dressing machines on the ground floor.

Grass and clover seeds are fed into the hopper to the band feeder from the top floor. Passing over the roughing out sieve, seed is elevated to pass through the seed cleaning separator and elevated again to feed either grass or clover cylinders. The clean seed is sacked off from the machines on the ground floor.

Such a plant as this is capable of handling cereal seed at the maximum rate of 3 tons per hour, grass seed at about 7 cwt. per hour and clover seed at about 12½ cwt. per hour.

A plant of this size will need at least four operators: one to feed the bins and look after the moving of sacks and three men to sack off from the powder dressing machines and weigh up and stack the clean seed. It would be advisable to have a fifth man who would be responsible for looking after all the machines.

Planning for old buildings

It will be noticed that the examples which have been given of these various installations are all those in which it has been reasonably easy to fit in the machines in the required manner. In many cases, however, it is much more difficult to plan a new installation into an old building, which may have quite a number of existing machines occupying much of the available space.

It is often found today that a merchant wishes to expand his plant to meet the demands imposed by the increased use of combine harvesters and the consequent increase in output required to handle large quantities of seed over a much reduced period. He is, however, by virtue of ' national restrictions,' unable to increase or extend his buildings and storage space.

This raises a serious problem, because it is not easy to raise output if storage space is much too small. The only hope is to acquire some form of storage space and overhaul the general position of transport and all possible co-operation by farmer customers. From the seed cleaning point of view, installation in a comparatively ' crowded ' building presents many difficulties, mainly due to the fact that in the past machines have been added to the plant in a very haphazard manner, with little thought to the future.

Factory Acts and dust collection

A great deal of consideration has recently been given to the question of dust collection (due to the requirements of the Factory Acts) and, although this is not of essential importance as far as output is concerned, it is worth while paying attention to this subject for the sake of having a clean mill inside and out, with obvious benefits from the point of view of labour, maintenance, prestige and maximum economy.

Man-power economy has just been mentioned and, without going into details, accessories such as sack elevators, chutes, quick-loaders, conveyors, man-elevators and stackers are well worth consideration in all types of buildings if the cost is weighed against saving in time and man-power.

Power consumption is also an important factor today. It is found that the majority of mills rely on electric motors to provide the required motive power. The ideal seems to be a grouping of machines (*i.e.* units) driven off several motors, as against individual motors for each machine. The main thing to do is to provide individual motors for machines which are likely to be run on their own, such as powder dressing machines or seed cleaning machines where large quantities of seeds will have to be cleaned on one machine.

Water power is, of course, very cheap and still often to be found in use, but the main problem there is the reliability of supply. Oil engines are also economical for the provision of power.

Final details of plant—flow of seed

When planning a seed cleaning plant, whether composed of one or more units, the most important point is the flow of the seeds through the machines.

It is essential to have as much flexibility as possible in order to make the most of the machinery for the handling of the various seeds. This is especially important for combined plants and for bigger firms with a larger number of machines.

As an example, let us take a combined seed cleaning plant installed in a mill. The building and positions of machines can be forgotten for the purpose of determining the flow of seed; all that must be remembered is the number of machines and the size of cylinders.

Let the plant consist of the following machines:

(1) Oat clipper and scourer.
(2) Band feeder and roughing out sieve.
(3) Seed cleaning separator.
(4) Grain cylinders (2), with indents of 5¼ mm. and 8 to 9 mm.
(5) Grass cylinders (2), with indents of 5 mm. and 10 mm.
(6) Clover cylinders (2), with indents of 2.3 mm. and 2.5 mm.
(7) Powder dressing machines.

In considering the flow of seed through the plant every advantage must be taken of all the machines. For instance, the following are examples of runs on various seeds.

Wheat. If necessary through the scourer to brighten the seed, then through the separator and on to the grain cylinders, using the 5¼ mm. to lift out cockle and wild vetch and the 8 to 9 mm. to lift wheat away from the barley. If a very small wheat is to be cleaned, then make use of the 5 mm. grass seed cylinder to avoid losing good seed. Remember that the speed of this cylinder will have to be increased for grain.

Oats. For clipping use the scourer with a woven steel cover, then through the separator for a good aspiration and removal of thin oats. From here through the 5¼ mm. grain cylinders to lift out short oats, cockle and odd small wheats, etc., and the 8 to 9 mm. cylinder for lifting out wheat and medium and small oats again. If, however, there is a contamination of barley, pass the oats through the 10 mm. grass cylinder and lift barley away into the tray of the cylinder. Again the speed of cylinders must be increased.

Barley. The same run is followed as for wheat, but if oats are present some difficulty may be experienced in removing them. In this case use the grass cylinders again, short oats being lifted out on the 5 mm. grass cylinder and barley being lifted in the tray of the 10 mm. cylinder, leaving good seed oats behind. The medium oats will pass through the wire grid bottom screen of the separator or be aspirated out.

With combined barley the scourer may prove useful, but the roughing out sieve even more so, as it gives the necessary pre-cleaning without any danger of cracking the barley if it is dry.

Grass Seed. From band feeder to roughing out sieve and then through the seed cleaning separator. From here normally through the 5 mm. and 10 mm. grass cylinders, but, if necessary, the 8 to 9 mm. grain cylinders will make a very efficient ' stalk ' separation from the smaller seeds. Remember that for grass seed the speed of the grain cylinders will have to be *reduced* considerably.

Clover Seed. A ' normal ' run is needed for clover seed, from band feeder to roughing out sieve, through the separator and on to the clover cylinders.

The above are examples where it will prove beneficial to make use of any of the machines for different seeds ; when going into the details of any plant it is essential to provide for alternate runs by way of an additional elevator, if necessary, and several two-way valves in the spouting.

It must be remembered that all the settings of machines—alternate runs *and* choice of sieves—are determined by the *impurity* in the seed being cleaned, and not by the seed itself.

It must be stated that the choice of the right sieves for the particular work being done is most important, and time is wasted trying to clean any seeds unless the correct sieves are available, to remove impurities in the seed as efficiently as possible, with minimum loss of good seed.

Problems are sometimes encountered where specialist machines have to be employed to separate an impurity. A typical example is the use of the Purex magnetic separator for the removal of plantain from clover. Special machines like this rely on particular characteristics of the seed for making a separation, such as a rough surface or a sticky surface as opposed to the more standard principles of separation (*i.e.* separation by specific gravity—aspiration; separation by width—reciprocating sieves, and separation by length—cylinders).

There is a limitation to the separations which can be made by these ' standard ' means, and a very acute problem at the moment is the separation of barley from seed wheat. The average specific gravity of these two seeds is almost identical in many samples, and with a large wheat and a medium-sized barley, identical in size, no way has yet been found of making absolutely perfect separations, although it is possible to get down to less than 1% on well-operated standard plants.

Unfortunately, any sowing of seed which has been cleaned, but still contains, say, 1% of barley, tends to make the position worse, as ' selected ' barley is being sown which is identical with the wheat and the following year's harvest will be even more difficult to clean for seed purposes.

Similar difficulty is found in the separation of brome from perennial ryegrass, and suckling clover from white clover in New Zealand. All such problems can only be solved by intensive research and co-operation by all concerned—the producer, the seedsman and corn merchant and the seed cleaning engineer.

Dried Lucerne for Transvaal

In the Vaal-Hartz Valley in the Transvaal plans are afoot to form a co-operative to establish plants for the dehydration of lucerne. According to Mr. J. J. du Toit, officer in charge of the Vaal-Hartz Agricultural Research Station, about 20 to 30% of the Union's lucerne crop is lost because of wasteful methods of harvesting, storage and feeding. In the Vaal-Hartz area, where approximately 30,000 tons of lucerne are produced annually, it is estimated that about 7,000 tons are wasted in this manner. The introduction of dehydration plants should do much to eliminate the losses, and the nutritional value of the concentrate would also be higher. It is estimated that four units, each costing from £20,000 to £25,000, would be needed to cater for the requirements of the Vaal-Hartz irrigation scheme. It is understood that a pilot plant may be erected in the near future.

Crop Protection in Many Lands

Open Day at Bourn

About 200 farmers and others attended an open day recently held at Bourn airfield, Cambridge, headquarters of Pest Control Ltd., when they had an opportunity to see the full range of the firm's spraying equipment. In his introductory talk the managing director, Dr. W. E. Ripper, gave an account of the work that has been done during the last year. Good results had been obtained from spraying fruit trees with systemic insecticides which, it had been found, did not destroy beneficial ladybirds and so it had been possible to reduce the number of sprayings required. Aerial spraying by helicopter on forests and hopyards had shown promising results and control of the yellow virus attacking sugar beet and mangolds had been effected by using systemics against the aphid vectors, particularly during the steckling stage. Dr. Ripper again emphasised the importance of employing trained men to handle dinitro and organic phosphorus compounds which can be extremely dangerous when in the hands of the unskilled.

The managing directors of three of Pest Control's overseas companies in the Sudan, Central and South Africa, were present at the demonstration. They and their staff are carrying out work against a variety of pests on the African continent. In the Sudan Gezira the campaign against cotton jassid (leaf hopper) takes place during a seven-week season in October and November, when about 180 acres are sprayed per day, working a 24-hr. day. A new field which has been opened up recently is the control of locusts by using DNC and the American chemical toxophene. An anti-malaria campaign is to be started this season with widespread spraying against mosquitoes. During the wet season there is often a severe shortage of labour because of this disease and at this season there is a particularly heavy demand on labour for weeding.

In Southern Rhodesia an anti-malarial campaign is also being carried out, while the work of the company there also includes fumigation of buildings against white ants, the fumigation of tobacco seed beds for the control of eelworm and spraying against cutworms attacking young plants in nurseries.

In South Africa the work includes the control by spraying of insect pests of deciduous fruits, *e.g.* apples, pears, apricots, citrus, etc., while work has been initiated on the control of caterpillars attacking castor oil plants.

Forage harvester in action. The modified delivery spout enables the tractor driver to spread the chopped material evenly without leaving his seat

Some Trials with Pit Silage-Making in New Zealand

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The making of silage in pits is standard practice in Great Britain, many parts of North Europe and in North America. In some other countries it has not yet become established and the following is an account of some recent experiments to overcome mechanical difficulties in pit-silage making under New Zealand conditions.

A GOOD deal of time and energy has been devoted to the improvement of pastures in New Zealand. What has been achieved has gained for the Dominion an enviable reputation for the production of dry matter per acre from its pastures. Improved grass seed, seed certification schemes, and the use of aerial top dressing for hill country are other outstanding contributions to pasture improvement from the Dominion. In the utilisation of pasture, however, New Zealand has fallen short of the high standards set on the production side.

Importance of fodder conservation

The stock carrying capacity of any farm is limited by the amount of food available during the winter months. To even out the food supply, some means of conserving part of the excess produced during the growing season is needed. In New Zealand the growing season is more prolonged than in European countries, but despite this, some means of preserving foodstuffs is essential to keep up production. A good deal of hay is made and also a certain amount of silage, mostly in the North Island. Hitherto silage has been made almost entirely in stacks, and the equipment used usually consists of a mower, a sweep and a mast and boom stacker. With this method the labour involved is considerable, and a certain amount of the final product is wasted. With a view to finding a better and quicker method of silage making, some experiments were carried out recently in the South Island on silage making in pits which reduces the waste and makes unloading easier.

Methods adopted

The equipment used consisted of a forage harvester and two specially adapted trailers. Two trailers are essential to provide anything like continuous work for a forage harvester and three ensure continuous working. Rapid unloading is a great help and may cut out the need for a third trailer. With a view to finding a quick method of mechanical unloading two different ones were tried in these experiments.

A well-drained site was chosen for the pit which was constructed with the help of a bulldozer. It took the usual form of a long trench with a ramp at either end; this can be produced easily by means of a bulldozer and allows through passage for the tractor and trailer after unloading. Gravel was spread on either ramp to make it possible for either filling or feeding out to take place in all weathers.

Trailer design

The deflector at the end of the delivery spout of the harvester was modified so that its position could be altered by the tractor driver: this did away with the need of a man to spread the load. The trailers used were single-axled and of the standard type found throughout the South Island. As the chopped material was blown back with considerable force some modification was essential to confine it and allow for mechanical unloading. Four sides were erected and twin doors made to open the width of the trailer at the rear. Metal hoops were erected over the rear three-quarter portion and canvas stretched over this framework 'prairie schooner' fashion. One trailer was equipped with a canvas extending the whole length and width of the floor and overlapping forward through

a space between the floor and the front end. The rear end of the canvas was attached to a roller which was wound up by hand through chain and sprocket reduction gearing. It should be noted that this roller could be driven from the power take-off by means of a shaft passing under the trailer. It would involve, however, the coupling and uncoupling of a power take-off shaft at frequent intervals. Two universal joints as well as reduction gearing or a slip clutch would also have to be provided. The other trailer was equipped with stout wire netting nearly to the width of the trailer and extending the whole length along the floor and over the front end. One end of the netting was held by staples at the rear of the trailer; the other had a 1 in. diameter pipe threaded through it. A suitable hitch was attached to the pipe at four evenly-spaced intervals.

Unloading routine

The dairy farm on which the experiments took place was under irrigation. Its pastures were mainly a mixture of rye grass and clover and there were also some pure stands of lucerne. In general it took about 8 minutes to fill a trailer under continuous working conditions, an average load being about 1½ tons of green material. In order to unload, the trailer equipped with netting was pulled into the pit and stopped where the load was wanted. A man at the pit opened the doors at the back of the trailer and handed the driver a rope which he attached to the hitch at the forward end of the netting. A tractor, used for consolidation during the intervals between unloading, was hitched to the rope and pulled the wire netting over backwards. The rope was long enough to allow this tractor to work outside the pit and so get a better grip with its rear wheels. The load was thus rolled out of the trailer very neatly. The trailer was then moved forward to drag the netting free of the heap. The tractor driver then picked up the netting, spread it on the floor of the trailer, closed the doors and moved out of the bottom end of the pit. The other man at the pit finished spreading, which was a very simple matter, due to the chopping of the crop into short lengths. The remainder of his time was spent in consolidating around the edges of the pit with the tractor, and in the application of molasses. The average time taken to unload by this method was 4 minutes.

It was found hard work to unload by hand the trailer equipped with canvas when the rear end was higher than the front. When in the reverse position, that is with the rear end lower than the front or level with it, unloading was easy. For this reason it was found most satisfactory to back into the pit with this trailer as often as was practicable, and to unload over the side for the remainder of the time.

Rolling the load from trailer to pit with the wire netting hitched to a tractor

Both methods of mechanical unloading speeded up the turn round of trailers. When netting was used three tractors were needed, one for the harvester, one for transport and one to help unloading, but when canvas was used two tractors only were needed. It must also be noted that the trailer equipped with a canvas can also be used to mechanise the process of feeding out.

Notes from Australia

Clover seed

The past season has been a most profitable one for growers of clover seed in both Victoria and Western Australia. Although the W.A. harvest is not quite complete, a record crop of about 2,000 tons of seed, valued at some £400,000, is assured. Most of the crop will be exported to the Eastern States and New Zealand. The crop is harvested by rolling the pastures with sheep skins or a type of matting. The clover burrs stick to this and are brushed off into containers, then threshed to release the seed, which is graded and bagged.

Sugar production

The president of the Australian Sugar Producers' Association (Mr. W. A. Brand) says that if sugar producers lose their 25% advantage in the exchange rate it will mean a total loss of £3 million in the annual value of the industry's exports. 'To offset this loss an increase of 1d. per lb. in the retail price of sugar in Australia will be required. The price of sugar in Australia today is less than it was 30 years ago, but this advantage to the consumer is possible only because of the high export income of the industry.'

Tobacco build-up

The Commonwealth Government hopes to build up Australia's tobacco production to a point where it will meet the Commonwealth's full requirements and also provide an export surplus. But at present Australia cannot meet her own tobacco requirements.

Another good wheat crop

Australian farmers recently harvested their third bumper crop of wheat in three years. Usually the expectation is two good harvests followed by a poor one, but thanks to the combination of good seasons and improved varieties of wheat the 1949-50 crop is expected to total 185 million bushels, compared with the 190,703,000 bushels of 1948-49 and the all-time record of 228,380,000 bushels of 1947-48. In New South Wales the current crop has yielded nearly 50% more grain to the acre than the previous average—some 18.7 bushels compared with 12.87 bushels. Plant breeders in every State are continually searching for new varieties with high yield, good baking qualities and resistance to rust diseases which, in 1947-48, cost growers in N.S.W. alone over £7 million.

New Guinea expedition

An expedition of Queensland plant breeders has recently visited New Guinea to search for new varieties of sugar cane. The present need of Queensland sugar planters is for early-maturing varieties which will enable mills to begin crushing operations much earlier than is now possible. Already the Queensland Bureau of Sugar Experiment Stations has done much good work, resulting in record productions in both the 1948 and 1949 seasons. In 1949 the total crushing was 6,568,000 tons of cane for 912,000 tons of 94 net titre sugar, or 875,000 tons of bagged sugar.

Farming by Fire

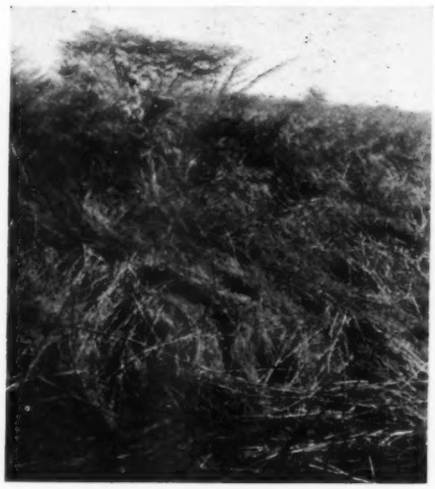
J. R. THOMSON

The unusual farming practice of burning off dry grass and saving a crop on the 'scorched earth' is practised in the Central Sudan. This novel form of cultivation could be expanded to alleviate the present grain shortage in that area and a full description of the process is given in the following article by our contributor—one-time Senior Inspector of Agriculture in the Blue Nile Province.

IN the central region of the Anglo-Egyptian Sudan, astride the Blue and White Niles, lies a vast tract of grassland interspersed with areas of spiny acacias. The most common acacia is *A. mellifera* with viciously curved thorns. The grasses are mostly annuals with *Sorghum purpureo-sericeum*, a close relative of Sudan Grass, and the fragrant *Cymbopogon nervatus* predominating. The soil is a dark coloured heavy cracking clay of the type usually called cotton soil. The rain, about 20 in. a year, falls between early July and mid-October; surface water collects in depressions but little is left by the end of the year. The banks of the Niles and their tributaries carry a dense population, human and animal, and are intensively cultivated, but away from the river, owing to the lack of water for most of the year except at occasional well centres, there is no permanent population and the goading of tabanid flies during the rains discourages nomadic herds. A limiting factor in farming is therefore not rain for the crops but domestic water for the cultivators.

Technique

In these vast empty spaces a form of cultivation is carried on which, as far as the writer knows, is unique to the Sudan —' ziraa b'l harig ' or cultivation by fire. The annual grasses germinate in August, begin to ripen off in November, shedding their myriad seeds into the soil, and by the end of the year the countryside is covered with a buff coloured mat of dead grass. During the following rains the seed germinates, the green shoots emerging through the mat of the previous year's grass, and it is at this time that the more adventurous riverain cultivator takes his bag of seed and meal and treks inland for the cultivation by fire. Following a few dry days the old grass is dry enough to burn and he sets it alight—it is never dry enough for the fire to get out of control. The fire destroys the new growth of grass and on the land thus laid bare the crop seed is sown, usually sorghum or perhaps sesame. If no more grass seeds germinate the cultivator can go home and remain there until harvest time. If there is a second germination he may remain to clear off the flush of weeds, but sometimes he just cannot be bothered and abandons the crop. Harvesting of early varieties starts in December and in the areas of heavier rainfall the late maturing varieties do not ripen until February.



In south central Sudan the grass is taller

Timing the burn

The timing of the burn is most important—if it is too early all the germinable grass seeds will not have sprouted and there will be a second flush, and if it is left too late there will be so much green growth that it will not burn at all. The happy mean is difficult to determine.

The " all clear " for burning is given by the senior sheikh of the area, but as everybody has a personal interest in the time of burning it is almost impossible to obtain an honest opinion. The nazirs, omdas, sheikhs and their friends favour a late date, for it will give a clean burn and even though the burned area be small their position will secure them a share of it. The ordinary man, however, realises that only if the burned area is extensive is he likely to get a share; this is more likely to happen if the burn is early and he is quite prepared to clean off a second flush of grass if necessary. The generally accepted time for burning is when the rain has penetrated to a forearm's depth and this usually happens about the middle of August, but a few days either way may make all the difference in the effectiveness of the burn.

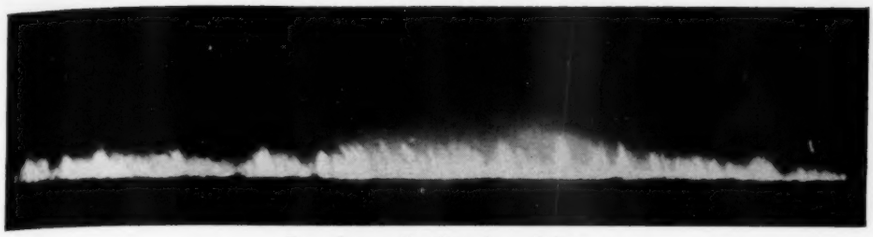
Choice of grasses

A good burn, of course, depends on a dense enough cover of old grass and this in turn is influenced by the previous year's rainfall. A thin cover will not burn, but if left until the following year the accumulated cover of two years is usually sufficient. Too heavy a cover, however, is not desirable as it is liable to give another flush of germination after burning. A lush growth of grass sheds an enormous crop of seeds and it is possible that the first seedlings are so numerous that they inhibit the germination of the laggards, which cannot sprout until their competitors have been burned off.

Perennial grasses are obviously useless as they shoot again after burning. Of the annuals, *Sorghum purpureo-sericeum* is the best as it falls over and gives a good burning mat compared with *Cymbopogon nervatus* and others which remain upright. Part of a burned area may be cultivated a second year, the so-called ' komadobe,' but most of it is allowed to tumble back to grass again. The first colonisers are dicotyledons and, temporarily freed from the competition of grasses, some acacias may establish themselves, but in three or four years the grass cover is again dense enough for cultivation by fire.

Advantages

The principal advantage of this form of cultivation lies in its economy of labour. All that is necessary is to sow and to harvest—there is no pre-cultivation and no weeding. Even if there is a second flush of grass, the weeding required is much less than for the crops grown on the village lands. Furthermore, it does not compete with the village-land crops for labour. The fire sorghum is not sown



Burning a fireline by night

until after the village lands have been sown and had their main weeding and it ripens after the village crops have been harvested. As the land has not been cultivated for several years the yields are greater. Burning may also enhance the yield by providing a dressing of ash, by counteracting the stickiness of the soil and by partial soil sterilisation.

Early in the war the pressing need to develop to the maximum the food producing potentialities of the country focused attention on this method of cultivation. Land and labour were limiting factors in the expansion of village cultivation, but development of fire cultivation would be one method of utilising the empty acres of the hinterland without any increase in the labour force. The measures adopted were at first regarded as temporary, but the need for food crops has not lessened and they are still being practised and indeed expanded.

Uncontrolled fires

From December onwards the dried up grass covers the countryside with a matting of tinder and, consequently, fires are only to be expected. The origin of these fires is seldom discovered, although they probably often start from a cooking fire left by a careless nomad, but once started and fanned by the prevailing north wind, they sweep across the countryside for hundreds of miles. Fires may start in November but seldom travel far, for there is still much grass that is too green to burn. Early fires are indeed beneficial, for the burned-out areas they leave act as breaks to stop later fires which otherwise might find no obstacle north of the swamps.

Control by firelines

After a fire, cultivation by this method is, of course, impossible and the first measure adopted for developing this kind of farming was the control of fires by firelines. The firelines are cleared on extensive and intensive systems. In the extensive system, east to west lines are cleared for long distances across country, for example from the Blue Nile to the White Nile, protecting grass whether good or bad from fires coming with the north wind. It is hoped eventually to score the country with a grid of such lines, but that has not been achieved yet. In the intensive system, if an area of uniformly good grass is found of, say, 500 acres or more, it is surrounded by firelines. As a necessary complement to the firelines an organisation of guards and patrols is maintained. Between the Dinder and Rahad rivers two high watch towers have been erected. When a fire breaks out the watchers on the towers take compass bearings and thus pin-point it on the map. From its location it is known whether it is likely to cause serious damage or not, and if necessary a fire fighting party is sent out on lorries. This system of fire protection has proved most effective and in some years there has not been an acre of fire cultivation outside the protected areas, the inference being that without protection there would have been none at all.

A fireline, to be effective, needs to be at least 80 yd. wide. For every mile of line this involves clearing the grass off 30 acres and at first no mechanical implements were available to do it. The enemy itself was therefore called in to help. In the Barles method, so-called after its originator, a narrow strip is cleared on each side of the line and then the grass between is carefully burned off starting on the downwind side. To begin with the strips were cleared by breaking the brittle grass with thorn branches drawn by camels and then raking it to the side by hand, but owing to inflation among the camel-men, camels are now difficult to obtain for work and tractor-drawn implements are being used. The burning requires a steady breeze and can only be done at night, for during the day the wind is strong and gusty, sparks are liable to fire the grass outside the line and the heat is too great for men to approach the fire. It is a tricky business, literally playing with fire, for if it gets out of control the results may be disastrous, but in fact this has seldom happened.

Water supply

Another limiting factor to cultivation by fire is water. There is usually enough surface water, dirty but drinkable, for the sowing and weeding season, but not at harvest and threshing time. The cultivated areas were restricted to the vicinity of depressions where water accumulated, but despite deepening by hand digging supplies often had to be supplemented by skins of water carried up from the river by camels. Drinking water was therefore transported to the cultivation areas by lorries or, if near the railway, by tankers. As soon as machinery became available, however, a programme was started of excavating reservoirs of up to 60,000 cubic metres capacity in catchment areas provided by the occasional small hills that erupt from the plain. There are now two teams of carryall scrapers working and there is several years' work ahead of them. The soil is impervious and losses from seepage are negligible, but at least a quarter of the stored water may be lost by evaporation and some method of reducing this loss is urgently needed.

It might be objected that this method of cultivation is liable to cause erosion by burning off the soil's cover of vegetation, but a crop is established immediately after burning and, in fact, the area of bare soil is less than under the regime of uncontrolled fires. The destruction of humus may be adduced as a criticism, but the soil contains naturally little humus, and in any case the incorporation of such nitrogen-poor material with the soil would seriously depress yields.

Importance of sorghum

The staple diet of most of the Sudanese is sorghum and it is to be hoped that it always remains so, for the country is capable of producing all its needs of this grain whereas it could never be self-sufficient in wheat. The Sudan used to export sorghum, but it is now realised that there never was a genuine surplus and that while grain was being exported men were going hungry. With the general improvement in prosperity there is now little hunger, the available grain is barely enough to meet the demand and prices are rocketing under the influence of speculative buying and hoarding. Tenants on the Gezira irrigated scheme are storing their grain crop and buying their needs in the market with cash from the cotton crop, and when their houses were treated last year with DDT as an anti-malarial measure stacks of grain sacks had to be moved to clear the walls for spraying. The only effective counter to this sort of behaviour is still more production. The village lands of the central belt can produce little more than the needs of the inhabitants and the surplus required to feed the towns and the more arid north must needs come from cultivation by fire in conjunction with more recent developments in mechanised farming.

A parade of British-made tractors took place each day in the Grand ring

The Greatest Show in Europe

The 1950 Show of the Royal Agricultural Society of England

THE Royal Agricultural Society of England held its first show 111 years ago at Oxford on 7 acres of land. Over 20,000 people visited it, some of whom took three or four days to get there, travelling by post-chaise and stage coach. It is recorded that on this occasion Thomas Bates, the pioneer of the Dairy Shorthorn breed, bought his animals from Middlesbrough to London by sea, from there to Aylesbury by canal, the remaining 23 miles being accomplished on foot.

This year the 'Royal' returned to Oxford for the third time in its history; on this occasion it covered 150 acres; there were upwards of 122,000 visitors, most of whom travelled by rail, coach or car, while, judging by the busy traffic on the adjoining airfield, a large number must have arrived by air also.

A record 'Royal'

It is usual for each succeeding 'Royal' to outstrip its predecessors and this one proved no exception; the number of entries in the live-stock classes was an all-time record, while the machinery section covered 40 acres. There was general agreement that the layout evinced an advance on any of its predecessors, although there is still need for more thorough sign-posting of avenues; it is true also that the heavy rain on the day previous to opening caused it to rank as one of the muddiest of these exhibitions, but these are minor points and the organisers are to be congratulated on having utilised the almost ideal site to produce an almost ideal show, while the quality of the exhibits was unsurpassed. There was a record attendance of overseas visitors, and many countries were represented; official visits were paid by the Netherlands Minister of Agriculture and a Canadian delegation.

A Royal champion

The grand parade of prizewinning cattle which took place every day after the first showed that British breeders can still produce animals of unsurpassed quality. Particular interest was displayed in the Red Poll female champion, six-year-old Royal Frolic, owned by the King. It was His Majesty's first Royal Show championship with this breed which, incidentally, won him the championship at the Royal Norfolk the week before.

Heavy draft horses continued to hold their place in the exhibition and 241 entries appeared in the four breeds, Shire, Suffolk, Percheron and Clydesdale, despite the growing competition of the tractor. Incidentally it is currently reported that more mares have been served this year, and horse-breeders are hoping that the decline of the farm horse may have reached its nadir and that the pendulum may swing in their favour for a change.

Educational exhibits

The educational exhibits at the show reached a high standard. The Ministry of Agriculture's exhibit covered 1½ acres and was an epitome of real agricultural progress. Its main theme was 'higher output with lasting improvement'; out of doors a series of plots demonstrated suitable rotations for four different types of farm, the main differences were in the length of leys, the types of stock food grown and the resting periods under different conditions, the object being to demonstrate how a farmer can get more from his land without drawing on capital resources. A circular plot in the centre of the exhibit showed the percentage of arable land which should be under various crops in 1952, the target for that year being 50% production above pre-war. Nevertheless 28% of the farming area will still be in permanent pasture.

Other plots demonstrated varieties of lucerne growing under different conditions, the management of grassland and the cultural and chemical control of weeds. The indoor exhibits included demonstrations on beef production from dairy herds by using colour marking beef bulls, pig feeding on home-grown foods, the correct use of silage and methods of grain handling and storing.

The National Federation of Young Farmers' Clubs staged a fine exhibit by young farmers from seven counties in S.E. England. This was the biggest display they have ever done and covered such diverse subjects as the story of wool from fleece to fabric, the history of agricultural machinery, gate hanging and fencing, methods of protecting hides and wool, and a collection of grasses.

Forestry

The forestry stand included, among others, exhibits by the Commissioners of Crown Lands, the Royal Institute of Chartered Surveyors and the Corporation

of the City of London. Among the aspects illustrated were planting to improve the amenities of a large industrial area and the importance of pruning forest trees early, while an interesting set of photographs showed the natural succession of growth on the non-calcareous soils of the Chilterns after withdrawal of grazing, with regeneration of heathland through birch and pines, to beechwood and beyond.

Machinery

The display of agricultural machinery was the largest ever seen in Britain. In all there were 730 trade stands as against 646 last year, with a vast array of tractors, implements and farm buildings, as well as fertilisers and feeding stuffs, insecticides, fumigants and, in fact, everything the farmer requires. The number of new implements on show was, however, less than in previous years. On the other hand a number of continental makes of tractors appeared, a sign that foreign competition to home manufacturers is returning.

A feature of the machinery section was the large number of exhibits of forage harvesting equipment, and in this connection the sponsorship of this type of machinery by the R.A.S.E. is obviously showing results. A number of new makes of pick-up balers appeared as well as machines for retrieving the bales after they have been dropped by the baler. Combine harvesters were well in evidence, not only American models but several British products as well. The range of tractor-mounted implements continues to expand, but the only horse-drawn wagon we saw was in the grand ring, and although the erstwhile so familiar bright splash of colour of the carts and wagons can still be seen at local shows it was not in evidence at Oxford.

Silver Medal awards

There were 21 entrants for the R.A.S.E. silver medal competition for farm machinery, of which five were awarded a medal. The machines selected were: a sugar beet top saver which severs the tops, picks them up on a spike wheel and delivers them into a side elevator; a root harvester capable of lifting two rows at a time and with a row width adjustment of 18 in. to 24 in.; a tractor-mounted post-hole digger consisting of a geared auger, driven from the power take-off; a grass drier for the smaller farmer, capable of producing 150 tons in a season when worked by one man; and a manure conveyor for cowhouses which scrapes the manure along a gutter running the length of the house and discharges it from an elevated loading platform.

Four more machines may re-enter for the competition next year after further tests have been made; they are a sugar beet topper with conveyor, a sugar beet lifter with elevator, a sugar beet harvester and a pea-cutter and swather.

Trade exhibitors reported that during the show they received many enquiries and obtained a considerable number of orders.

Next year's show

Cambridge has been selected by the R.A.S.E. as the venue for next year's show and work has already started on preparing the site for it.

(Photo: R.A.S.E.

Aerial view of the 150 acres showground of the 1950 'Royal'

New Sugar Beet Process

At least three sugar beet factories in the United States have adopted a new process which reduces water consumption by 30%, increases sugar yield by 1.5% and greatly minimises the trouble of pollution by effluents. The process is based upon the idea of re-using the waste waters for further extractions.

In the orthodox system the milled beets are extracted with fresh water, and eventually the pulp-washing water and the water from draining and pressing the pulp are discarded. It has generally been considered impossible to re-use these washing waters, although they still contain some sugar. Fermentation quickly reduces the sugar value, and non-sugar materials also dissolved in the water would in any case complicate sugar purification processes. These wastes contain a good deal of suspended matter, are objectionable, and their disposal is often associated with further costs.

In the new recovery process they are immediately chlorinated; about 40 parts per million of chlorine are sufficient to destroy bacteria. Lime is added to maintain a suitable pH level. The chlorine also causes the precipitation of most of the non-sugars dissolved in these waste liquors. After standing in sedimentation tanks, the washings, largely free from both suspended and non-sugar matter, are added to fresh water for further use in the extraction of milled beet.

It is claimed that the process extracts an extra 4 lb. of sugar per ton of beet. Applied to all U.S. sugar beet factories it would save 20,000 tons of sugar per year, equivalent to the yield from some 9,000 acres of beet.

From *Food Manufacture*, Vol. XXV, 6, p. 223.

A 'Royal' for Africa

Royal floating trophies will be a feature of Southern Rhodesia's new Royal Agricultural Show, the first of which will be held at the Salisbury showground for four days from August 30 to September 2. The Royal trophies will be contested for in addition to the usual annual show trophies. To organise the Royal Show a separate society—the Royal Agricultural Society of Southern Rhodesia—has been formed. A Royal Show will be held every three years, the second being in Bulawayo to coincide with the celebrations of the occupation of Matabeleland.

Among the many trophies to be presented will be one for white hybrid maize and one for the most points gained in the tobacco section.

FARM MACHINERY

The trailer-unloading winch for the Templewood Mark I grass drier (mentioned in the June issue) is an additional piece of equipment

The one-man pick-up baler; this is a lightweight machine weighing approximately 1½ tons

The new Massey-Harris artificial manure distributor folded down for transport; the sowing width is 15½ ft.

France—Costly Fuel

Although production of tractors in France is most promising, the high price of fuel is preventing farmers from buying them, except for the small electrically driven models. Last year 17,290 tractors were produced and it is estimated that production this year will reach 20,000. As it is uncertain whether French agriculture will absorb the 1949 production, tractor imports under the Marshall Plan will be stopped.

A reduction in fuel costs would change the situation completely, says our Paris correspondent, and France would soon cease to be relatively backward in mechanised farming.

One-Man Baler

The lightweight one-man baler shown in the photograph weighs approximately 1½ tons and is a combination of a small diameter pick-up and elevator carrier chains, feeding into an auger, which delivers to a feeding head. The knotter is kept clear of trash by means of a fan. The machine is powered by an air-cooled auxiliary engine and is therefore independent of the tractor power take-off.

Massey-Harris have also produced a new artificial manure distributor having a swing width of 15 ft. 6 in. folding down to a transport width of just over 8 ft. This machine is mounted on four wheels on which the weight is distributed evenly and a platform in front of the box can carry a load of 10 cwt., enabling 8 acres to be spread with a 2 cwt./acre dressing without any auxiliary transport to carry the sacks of manure.

A Continental Tractor

A new tractor on the home and overseas markets is the Tract Continental, manufactured in France by the largest European producers of heavy tracklayers. Four models of 30, 40, 60 and 70 h.p. are available. The 60 h.p. model gives a drawbar pull of 15,250 lb., and has a maximum working speed of 5.3 m.p.h.

Rotary Attachments

The Howard Rotovator shown in the photograph on right has been found to be particularly suitable for turning in sugar cane trash. Drawn behind a crawler tractor it has a working width of 95 in. and an overall width of 9 ft. 2 in. The machine works to a depth of about 12 in.

The extension of agricultural teaching in rural secondary schools in Great Britain is an important development. The Wareham County Secondary School, Dorset, is among those which recently inaugurated a school farm and our picture shows some of the pupils learning the rudiments of tractor ploughing

New Course for I.B.A.E. Exam

The College of Aeronautical and Automobile Engineering in London is opening an agricultural engineering department in the autumn which, it is claimed, will provide the first comprehensive practical and theoretical course in agricultural engineering in the United Kingdom. It is planned to train students to take the examinations of the Institution of British Agricultural Engineers.

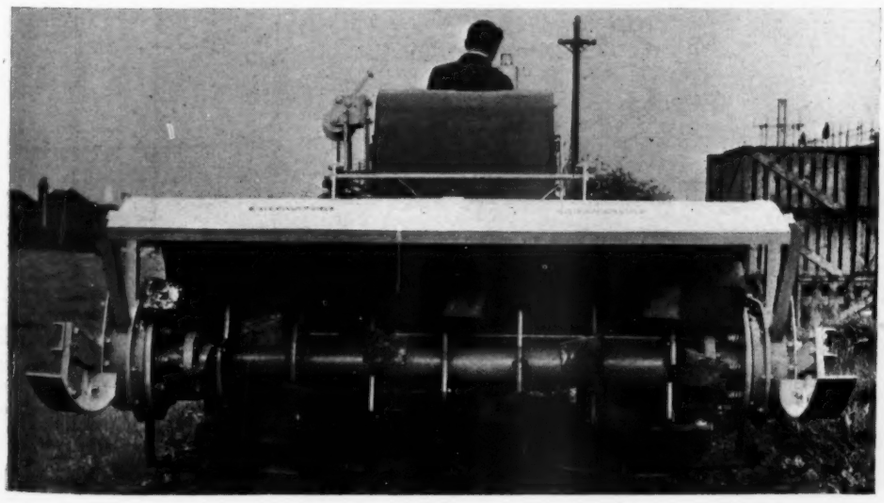
The syllabus of the new course, which will run for 18 months, includes practical and theoretical training in all forms of internal combustion engines and agricultural machinery. It will cover practical work in engineering and electrical workshops and in the drawing office. The theoretical section will deal with engineering science, geology, crop and animal husbandry and the economics of farm machinery.

The final period of the course will be spent with operators of agricultural machinery and on farms to obtain experience of equipment under actual working conditions. Students with previous engineering experience will be able to complete the course in less than 18 months.

It is expected that many overseas students will attend the course.

India to Buy Tractors

In order to help meet India's requirements for suitable agricultural tractors and implements and to see that their distribution within the country is rationalised, the Government have decided to issue licences for the import of tractors and matched implements from all sources, including the U.S.A., Canada and other hard currency areas.



Progress of India's Jute Industry

In the report of the Indian Ministry of Agriculture for 1949-50, progress in the extension of the acreage under jute is described. The report observes: 'To meet the shortage in India's jute supply consequent on partition, the Indian Central Jute Committee pressed with vigour the three-year scheme for maximising the production of jute which was started in 1948-49. The measures undertaken in 1949-50 include improved methods of cultivation, distribution of imported seeds, manures and fertilisers, educative propaganda among cultivators and the introduction of jute cultivation in new areas not used for food production. The production of jute in 1949-50 is estimated to be over 26 lakh bales as against 20.3 lakh bales in 1948-49. The annual grant of £27,500 to the Jute Committee has been doubled to enable it to continue its increased activities. The committee's field staff undertook a complete survey of the jute-growing areas and new areas for jute growing. As a result, it has been estimated that it should be possible, by double cropping alone, to increase the acreage under jute by 3,200,000 acres without affecting food production. India's total requirement of jute is 7,000,000 bales as against an estimated production of only 2,500,000 bales during 1949-50. Plans have been drawn up for attaining a production of 5,000,000 bales, by intensifying development, assisting growers, providing retting and transport facilities and double cropping. These development works will be controlled by the Central Government and the expenditure will be met from a special grant of a little over £180,000.

Granular Fertiliser Factory for Salisbury

A £250,000 factory for the manufacture of granular fertilisers is nearing completion at Lytton, near Salisbury. The main building is 370 ft. long and 254 ft. wide. The factory has been fully mechanised. Two modern bagging plants have been provided and bags are automatically loaded into railway trucks. There are four railway sidings, three of which are inside the factory, as well as office and laboratory blocks, homes for the European and native staffs and other amenities.

It is expected that supplies of granular fertiliser will be available to farmers in 1951.

WORLD CROP REPORTS

Mozambique affected by import control

Dissatisfaction is felt in the Mozambique over the Union of South Africa's trade policy. There is plenty of tea, bananas, rice and vegetable oils in that territory. They could be delivered to markets on the Rand in a day. But import control not only keeps them out but has also hit the Portuguese trader hard. Portuguese observers maintain they can play a vital part in keeping down the Union's living costs. Owing to the Union's reluctance to trade with Mozambique, the Portuguese are turning their attention to European and American markets. America now buys all Mozambique's available tea, and Italy and Lisbon are expected to provide ready markets for her bananas. Business men in Lourenco Marques believe that import control is not in accordance with the Mozambique Convention. Before import control Mozambique exported large consignments of bananas to the Union—14,000 to 20,000 crates a month. Import control reduced the figure to about 4,000 crates a month. This drastic cut almost ruined many plantation owners, who were forced to sell their bananas at 1d. a dozen. Mozambique produces high quality rice which could be exported to the Union. The Union only imported 15,739 lb. of this rice during 1949, compared with 37,000 lb. in 1945.

Canadian crop report

The Dominion Bureau of Statistics have issued the following preliminary estimate of areas sown to field crops in Canada:

Acreages	1950	1950	1949	1948
All Canada		*Intentions*	*Final*	*Final*
		(*Thousands of acres*)		
Spring wheat	26,100	—	26,736	23,247
All wheat ..	27,000	27,200	27,541	24,105
Oats	11,600	12,000	11,389	11,201
Barley ..	6,600	6,900	6,017	6,495
Linseed ..	500	500	321	1,876
Prairie provinces		*Spring wheat*		
Manitoba ..	2,400	2,900	3,167	2,397
Saskatchewan	16,200	16,900	15,737	14,389
Alberta ..	7,200	7,300	7,586	6,259
TOTAL ..	25,800	27,100	26,490	23,045

Cyprus plants new citrus

According to the Cyprus Department of Agriculture, planting of new citrus, which had stopped during the war years, is now in full swing. The late Valencia variety of orange is the one in greatest demand for new plantings.

Record Cuban tobacco output

Cuba's 1949-50 production of leaf tobacco, which is estimated at 88% above the 1948-49 harvest, is the largest tobacco crop on record for that country, according to the American Embassy in Havana.

Due to the large 1949-50 crop, Cuban stocks of leaf at the end of the current calendar year are expected to total approximately 125 million lb. This compares with stocks of about 90 million lb. on December 31, 1949, and 98 million lb. at the end of 1948.

Italian fruit harvest

According to reports collected by the Central Institute of statistics in Rome, the following is the estimated crop of the principal types of fruit grown in Italy in 1950:

	Tons	1949
Apples ..	567,000	15% less
Pears ..	318,000	5½% less
Peaches ..	248,000	7% more
Apricots ..	21,000	7% more
Plums ..	78,000	2½% less
Almonds ..	172,000	—
Walnuts ..	44,000	—

Chile's oilseed crops larger

Chile is rapidly begoming self-sufficient in the production of oil-seeds for the manufacture of edible vegetable oils, according to the American Embassy, Santiago. Sunflower seed is the chief raw material used, and provided prices remain above competitive cash crops, Chile soon should be able fully to satisfy her domestic requirements. Imports of oilseeds in the past few years have decreased greatly and the number of local processing factories has increased to at least 10.

The 1949-50 sunflower seed crop is estimated at about 65,900 short tons from 108,500 acres, the largest crop in Chilean history, and almost 19% larger than the 55,490-ton harvest of 1948-49. The steadily increasing area sown to sunflower seed for edible oil has been due to the Government's policy of guaranteeing high prices for its production.

Hempseed production amounted to 3,300 tons from 7,800 acres in 1949-50 or 30% less than the 4,760 tons from 11,430 acres the previous year. This was the smallest crop since before the war, a fact attributed by oil factories to the lack of interest in increasing hemp fibre production.

There are no official figures for rapeseed. Production is estimated at 4,000-4,400 tons. Rapeseed oil is successfully blended with sunflower seed oil for table use.

About 80 tons of grapeseed oil are produced annually. Since the oil is somewhat acid, it is blended with other oils for edible purposes.

A small quantity of rice oil—about 33 tons per month—is processed from rice bran. About 20% of sunflower seed oil is mixed with it to make it palatable.

Chile produced about 590 tons of olive oil in 1949 from olives produced from roughly 255,000 trees. It is believed that there are about 950,000 olive trees in Chile but that only about 25% are now in production.

The only seed reported grown for the production of inedible oil is flaxseed. The 1949-50 crop amounted to 147,400 bushels from 12,900 acres, a decrease of 39% from the 1948-49 crop of 241,200 bushels from 18,700 acres.

S. Africa's oilseed crops, 1949-50

The Union of South Africa's 1949-50 groundnut crop is down from the past two years, but the sunflower seed crop exceeds that of last season, according to the American Embassy, Pretoria. Preliminary unofficial estimates place the groundnut harvest at 60,000 short tons against 67,000 a year ago and only 12,000 pre-war and the sunflower crop at 35,000 tons compared with 20,000 in 1948-49 and less than 2,000 pre-war. The only significant change in other oilseeds is the increase in cottonseed. The 1949-50 output is estimated at about 8,000 tons compared with 2,000 in 1948-49 and 1,000 pre-war.

Production will be sufficient to supply domestic requirements of groundnuts and oil and sunflower seed and oil with the possibility of some exportable surplus of sunflower seed oil.

Zanzibar's clove crop

Zanzibar shows promise of a very good crop of cloves for the season commencing July 1, 1950. The crop estimate for the first part of the seasonal year is 2,500 tons for Zanzibar and 12,500 tons for Pemba. Stocks from previous crops are well-nigh exhausted. Reports from Madagascar give a crop estimate for the year 1950 of from 3,000 to 3,500 tons with small stocks only on hand.

The Clove Growers' Association of Zanzibar has raised its buying price to 90s. per 100 lb.